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On *Megalepthyphantes lydiae* Wunderlich, 1994 (Araneae: Linyphiidae)

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Abstract: *Megalepthyphantes lydiae* Wunderlich, 1994 is redescribed and illustrated on the basis of new material from Greece. Judging from the structure of the palp, this species is similar to the north-African *M. auresensis* Bosmans, 2006 and *M. bkheitae* (Bosmans & Bouragba, 1992). In the peculiar shape of its embolus *M. lydiae* resembles the Irano-Caucasian *M. camelus* (Tanasevitch, 1990). From these species *M. lydiae* is clearly distinguished by structural details of the genitalia in both sexes.

Keywords: Spiders - Micronetinae - redescription - Mediterranean - Greece.

INTRODUCTION

Megalepthyphantes lydiae Wunderlich, 1994 was originally described from Greece on the basis of a male and a female from Naxos Island, and a female from Epidaurus (Wunderlich, 1994). A re-examination of the male holotype revealed that the author illustrated a left palp with a broken distal part of the lamella characteristica, while the right palp is intact. Spider material collected by Antoine Senglet from Greece in 1972 contains a male and two females of *M. lydiae*. The redescription and illustration of this species is the subject of the present paper.

MATERIAL AND METHODS

This paper is based on material kept at the Muséum d'histoire naturelle de Genève, Switzerland (MHNG) and the Senckenberg Museum Frankfurt am Main, Germany (SMF). Specimens preserved in 70% ethanol were studied using a MBS-9 stereomicroscope. The terminology of copulatory organs mainly follows that of Merrett (1963) and Saaristo & Tanasevitch (1996). The chaetotaxy is given in a formula, e.g., Ti I: 2-1-1-2(3), which means that tibia I has two dorsal spines, one pro-, one retrolateral spine, and two or three ventral spines (the apical spines are disregarded). The sequence of leg segment measurements is as follows: total length (femur+patella+tibia+metatarsus+tarsus). All measurements are given in mm. All scale bars in the figures correspond to 0.1 mm.

Abbreviations

Ca	carina *sensu* Saaristo & Tanasevitch (1996)
DPS	distal part of scape *sensu* Saaristo & Tanasevitch (1996)
E	embolus
EP	embolus proper *sensu* Saaristo (1971)
L	lamella characteristica
MM	median membrane *sensu* Helsdingen (1965)
PH	pit hook *sensu* Saaristo & Tanasevitch (1996) = distal suprategular apophysis *sensu* Hormiga (2000)
PMP	posterior median plate *sensu* Helsdingen *et al.* (1977)
PS	proscape *sensu* Saaristo & Tanasevitch (1996)
SS	serrate surface of embolus *sensu* Saaristo & Tanasevitch (1996)
T	tooth
TA	terminal apophysis
TmI	position of trichobothrium on metatarsus I

RESULTS

Megalepthyphantes lydiae Wunderlich, 1994

Figs 1-13

Type material examined: SMF, #39732 and #39756; male holotype and female paratype of *M. lydiae*; GREECE, Naxos; XI.1983; leg. J. Wunderlich.

Other material examined: MHNG; 1 male, 2 females; GREECE, Aetolia-Acarnania, between Chrisovergi and Aitolikón; 14.IX.1972; leg. A. Senglet.

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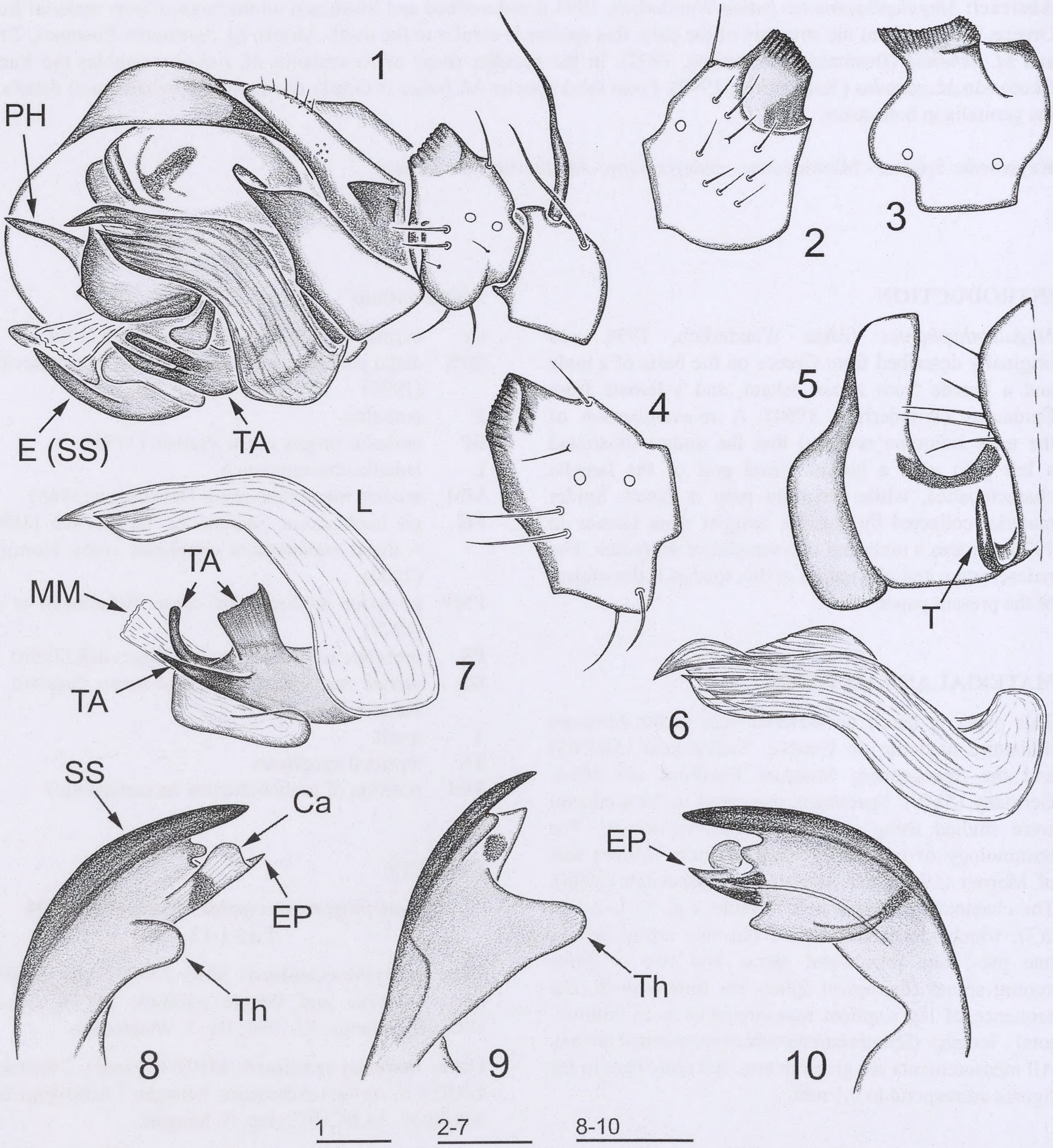
Description of male from Aetolia-Acarnania: Total length 4.25. Carapace 1.90 long, 1.45 wide, unmodified, pale brown to yellow, dorsally with a narrow, dark, longitudinal stripe becoming bifurcated in cephalic part. Chelicerae 0.75 long, unmodified. Legs yellow, distal ends and middle parts of segments darkened. Leg I 11.30 long (3.00+0.55+3.00+3.00+1.75), IV 8.20 long (2.50+0.45+1.95+2.05+1.25). Chaetotaxy. FeI: 0-1-0-0, II-IV: 0-0-0-0; TiI: 2-1-1-2(3), II: 2-0-1-2(3), III: 2-1-1-1(0), IV: 2-1-1-0; MtI-IV: 1(2)-1-1-0. TmI 0.14. Metatarsi IV without trichobothrium. Palp (Figs 1-10): Patella with two curved special spines (see Saaristo & Tanasevitch, 1996) of different sizes. Tibia dorsally with a short ridge and a rounded depression in its retrolateral side. Paracymbium relatively large, proximal part with a tooth ("T" in Fig. 5). Lamella



Figs 1-10. *Megalepthyphantes lydiae* Wunderlich, 1994, details of left palp of male specimen from Aetolia-Acarnania. (1) Distal part of palp, retrolateral view. (2-4) Tibia, prolateral, dorsal and retrolateral view, respectively. (5) Paracymbium, retrolateral view. (6) Lamella characteristica, retrolateral view. (7) Embolic division, retrolateral view. (8-10) Embolus, different aspects.

characteristica massive, bent in distal third, with a beak-shaped apex. Terminal apophysis consisting of three parts: a small, straight, wide ridge and two narrow processes: one straight, pointed, stylet-shaped, other one bent and blunt. Embolus relatively large, its serrate surface extended forwards, forming a spear-shaped apex. Carina very small, thumb large, rounded. Embolus proper short, pointed. Abdomen 2.50 long, 1.50 wide, dorsally pale, with two longitudinal rows of grey sports interconnected by transverse stripes.

Description of female from Aetolia-Acarnania: Total length 4.35. Carapace 1.75 long, 1.30 wide. Chelicerae 0.80 long. Leg I 9.85 long (2.65+2.55+0.6+2.50+1.55), IV 8.70 (2.60+2.05+0.5+2.25+1.30). TmI 0.16. Metatarsi IV without trichobothrium. Abdomen 2.55 long, 1.75 wide. Epigyne (Figs 11-13): Proscape strongly sclerotized, slightly narrowed at its base. Distal part of scape swollen, lateral lobes and stretcher totally reduced. Posterior median plate blackish, with a deep median notch in distal margin. Body and leg coloration, and chaetotaxy as in male.

Taxonomic remarks: The structure of the palp of this species is similar to that of the north-African *M. auresensis* Bosmans, 2006 and *M. bkheitae* (Bosmans & Bouragba, 1992). The shape of the embolus, particularly the serrate surface extended forwards and forming a spear-shaped apex, of *M. lydiae* resembles that of the Irano-Caucasian *M. camelus* (Tanasevitch, 1990). From the three species mentioned above *M. lydiae* is clearly distinguished by the structural details of its male palp, especially by the shape of the apophysis on the palpal tibia, and by the structure of the paracymbium and the lamella characteristica. The shape of the epigyne of *M. lydiae* is similar to that of many congeners, but differs clearly by the deeply notched posterior median plate.

Distribution: Known only from Greece: Naxos Island and Epidaurus (Wunderlich, 1994), as well as Aetolia-Acarnania (new data).

ACKNOWLEDGEMENTS

I am greatly indebted to Peter Jäger and Julia Altmann (SMF), who provided the type material under their care, as well as to Peter Schwendinger (MHNG) for the opportunity to work with the collections of the MHNG and for editing the manuscript. Thanks also go to Dragomir Dimitrov (National Museum of Natural History, Sofia, Bulgaria) who kindly reviewed the manuscript.

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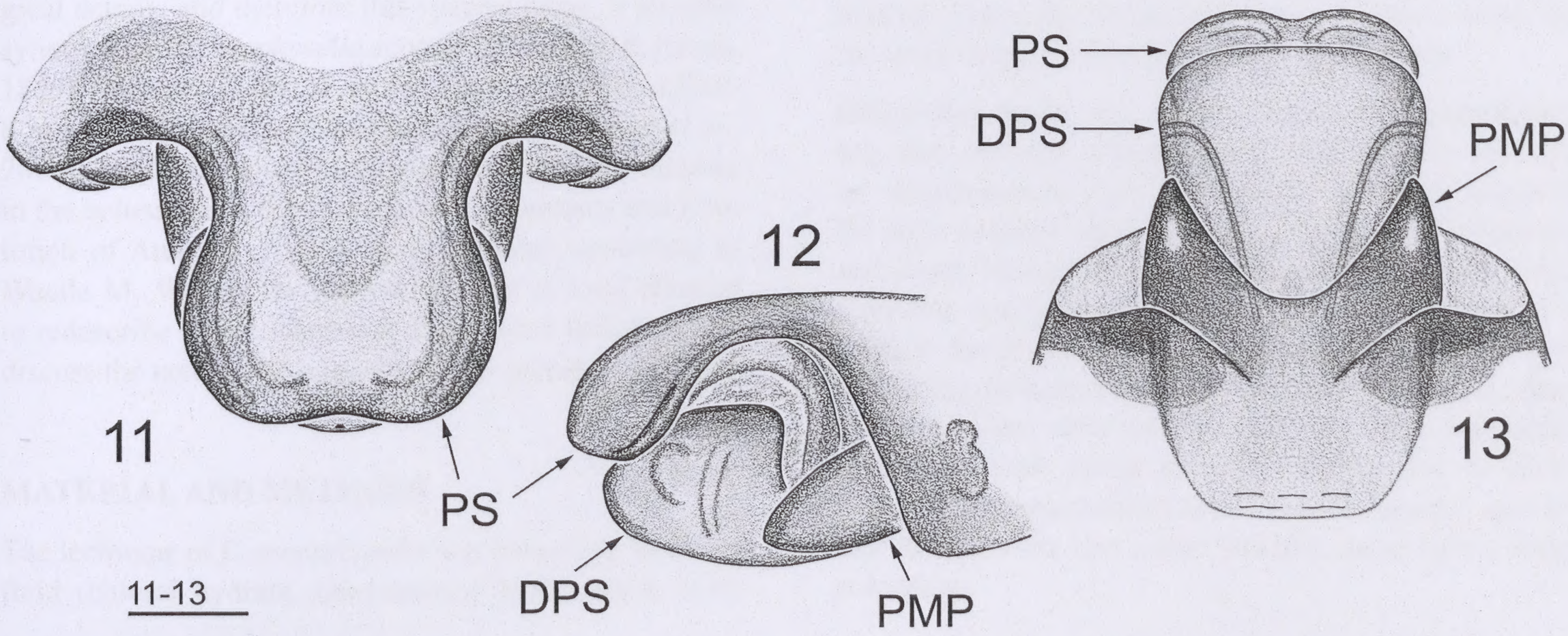

Figs 11-13. *Megalepthyphantes lydiae* Wunderlich, 1994, epigyne of specimen from Aetolia-Acarnania. (11-13) Ventral, lateral and dorsal view, respectively.

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Ceratophysella macrocantha Stach, 1946 (Collembola, Hypogastruridae): a redescription of a forgotten species from the Alps

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Abstract: *Ceratophysella macrocantha* Stach, 1946 is redescribed on the basis of a syntype specimen from the Austrian Alps which is here designated as the lectotype. This species has the chaetotaxy of the type B and an empodium with a long filament. It is closely related to nine species/forms, two of which, *C. attenuata* Gisin, 1960 nec Cassagnau, 1959 from the Swiss Alps and *C. recta* Cassagnau, 1959 from the Pyrenees, are most similar.

Keywords: Taxonomy - springtails - Europe.

INTRODUCTION

Ceratophysella Börner, 1932 is one of the most species-rich genera within the family Hypogastruridae. Unfortunately, some of the 138 species currently listed by Bellinger *et al.* (2019) are insufficiently known and there are doubts concerning their taxonomic status. One of these is *Ceratophysella macrocantha* Stach, 1946. This characteristic species, with a large body size and long anal spines, has been described by Stach (1946) on the basis of two specimens collected by Dr Herbert Franz in the Austrian Alps. This species has not been recorded ever since, and as a consequence our knowledge of its morphology is exclusively based on the original description. Unfortunately, Stach did not provide comprehensive information on chaetotaxy and some other morphological details, and therefore this species name, a possible synonym of *Ceratophysella scotica* (Carpenter & Evans, 1899), was not included in the most recent identification key of Palaearctic Hypogastruridae (Thibaud *et al.*, 2004). An examination of the only syntype that remains in the collection of the Institute of Systematics and Evolution of Animals, PAS, Cracow, Poland (according to Wanda M. Weiner the second syntype is lost) allowed to redescribe *C. macrocantha*, designate a lectotype and discuss the taxonomic position of this species.

MATERIAL AND METHODS

The lectotype of *C. macrocantha* was cleared in Nesbitt's fluid (chloral hydrate, concentrated hydrochloric acid, distilled water), slide-mounted in a mixed medium (distilled water, gum arabic, glycerol, chloral hydrate), and studied using a Nikon Eclipse E600 phase contrast microscope. Figures were drawn using a camera lucida. Terminology in the description follows that given in Babenko *et al.* (1994) and Thibaud *et al.* (2004).

TAXONOMIC PART

Ceratophysella macrocantha Stach, 1946

Figs 1-8

Type material: Female lectotype, designated here, previously in alcohol, now mounted on permanent slide, deposited in the Institute of Systematics and Evolution of Animals, PAS, Cracow, Poland; Styrian Alps, Buchau, east ridge, about 850 m asl., in beech forest on the south slope; 21 October 1941; leg. H. Franz.

Diagnosis: Body size large. Tegumental granulation fine and uniform. Chaetotaxy of the type B, setae p_3 on abdominal tergum IV absent. Antennal segment IV with trilobed apical vesicle, 7 cylindrical sensilla and about 18 slightly modified sensilla in ventral field. Eversible sac between antennal segments III and IV weakly developed. Head of maxilla with lamella 1 protruding beyond the teeth and broadened at the tip. Outer maxillary lobe with two sublobal hairs. Empodial appendage with apical filament reaching tip of claw. Dens with 7 unmodified setae, mucro slender, spoon-like at tip, with low outer lamella. Anal spines long colourless.

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Redescription: Body length 2.4 mm. Colour (in alcohol) mostly dark blue, ventrally paler. Tegumental granulation fine and uniform, 27 granules between widely spaced macrosetae p_1 on abdominal tergum V (Fig. 6).

Arrangement of setae on head typical for the genus, spine-like setae absent. Dorsal chaetotaxy of type B (Figs 5-6). Thoracic tergum II with setae m_3 and m_4 present, setae a_2 similar to a_3. Setae p_1 on abdominal tergum IV developed as macrosetae, p_2 as microsetae, setae p_3 absent, additional setae m_2 present. Abdominal tergum V with long a-setae, setae p_2 present. Differentiation of dorsal setae into micro- and macrosetae distinct. Setae long (ratio p_5 macrosetae on abdominal tergum II/inner edge of claws III = 1.7), straight, pointed at tips and slightly serrate. Body sensilla (s) relatively long, but mostly shorter than macrosetae (only on abdominal tergum V slightly longer). Microsensilla (ms) on thoracic tergum II present (Fig. 5). Subcoxae I, II, III with 1, 2, 3 setae, respectively.

Antennal segment IV with trilobed apical vesicle, subapical organite (or), microsensillum (ms), 7 (2 lateral, 5 dorsal) cylindrical, subequal sensilla and about 18 thin, slightly curved and blunt-tipped sensilla in ventral field (Fig. 1 and Stach, 1946: pl. II, fig. 1). Antennal segment III organ with two long (lateral) and two short (internal) curved sensilla (Fig. 1). Microsensillum on antennal segment III present. Eversible sac between antennal segments III and IV present but weakly developed. Antennal segment I with 7 setae.

Ocelli: 8 + 8. Postantennal organ 2.6 times as large as single ocellus; the former with four lobes, its anterior pair larger than posterior pair. Accessory boss present (Fig. 2).

Labrum with 5, 5, 4 setae; 4 prelabrals present. Maxillary head (not well visible) as in Figs 3 and 4. Lamella 1 broadened at tip, protruding beyond teeth. Outer maxillary lobe with two sublobal hairs. Labium hardly visible.

Tibiotarsi I, II, III with 19, 19, 18 setae, respectively. Tenent hairs a little shorter than inner edge of claws, pointed. Claws with inner tooth and a pair of lateral teeth. Empodial appendage with broad lamelliform base and filiform apex reaching tip of claw (Fig. 7).

Ventral tube with 4 + 4 setae. Furca well developed. Ratio dens + mucro/inner edge of claw III = 2.2, ratio dens/mucro = 2.1. Dens with uniform fine granules and 7 unmodified dorsal setae (basal macroseta slightly exceeding half of dens length). Mucro slender, spoon-like at tip, with low but distinct outer lamella (Fig. 8). Retinaculum with 4 + 4 teeth.

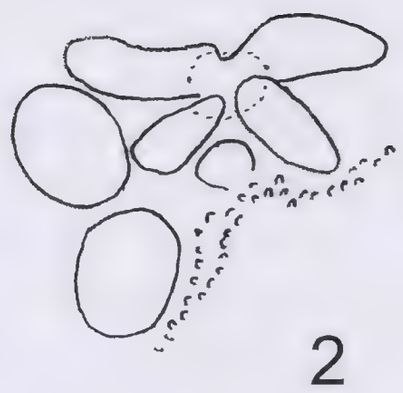
Anal spines long (1.4 times as long as inner edge of claws III), slightly curved, situated on basal papillae, unpigmented (Fig. 6).

Remarks: *Ceratophysella macrocantha*, having chaetotaxy of the type B and an empodium with a long filament, is similar to six European species/forms of the *armata* group: *C. attenuata* Gisin, 1960 nec Cassagnau, 1959 (Swiss Alps, from cave), *C. lawrencei* Gisin, 1963 (Alps, Appenines, Carpathians), *C. penicilifer* Cassagnau, 1964 (France - Massif Central), *C. recta* Cassagnau, 1959 (Pyrenees), *C. scotica* (Carpenter & Evans, 1899) (Belarus, Germany, Great Britain, Ireland, Norway, Poland, Ukraine) and *C. tergilobata* (Cassagnau, 1954) (Mediterranean), and also to three Asian species: *C. empodialis* Babenko *et al.*, 1994 (Russia - Far East), *C. liguladorsi* Lee, 1974 (Korea, China, Russia - Southern Sachalin, Indonesia) and *C. paraliguladorsi* Nguyen, 2001 (Vietnam) (see Gisin, 1960; Babenko *et al.*, 1994; Thibaud *et al.*, 2004; Nguyen, 2001; Skarżyński, 2006).

Ceratophysella tergilobata, *C. liguladorsi* and *C. paraliguladorsi* can be easily distinguished from *C. macrocantha* by the presence of a characteristic medial spine-like integumentary projection between the bases of setae p_1 on abdominal tergum V. Easy to distinguish are also *C. lawrencei* and *C. scotica* (integument with fields of coarse granules), *C. penicilifer* (six setae on dens, filament of empodium split into three or four branches) and *C. empodialis* (boat-like mucro as typical for the genus).

Closest to *C. macrocantha* (probably conspecific) seem to be *C. recta* and *C. attenuata*. Both differ from the species redescribed here in subtle characters. The first of the above-mentioned has a simple apical vesicle on antennal segment IV, the filament of the empodium ¾ the length of the inner edge of the leg claws, the mucro is almost without an outer lamella and the tenent hairs on the tibiotarsi are clearly longer than the claws. *Ceratophysella attenuata*, of which I examined four specimens (3 females, 1 male on one slide labelled by Gisin: *Ceratophysella attenuata*, Fikenloch, cave near Jochpass, canton Obwald, central Switzerland, 2450 m asl., 18.08.1959, leg. M.M. Aellen, Roth and Strinati, deposited at the Muséum d'histoire naturelle in Geneva, Switzerland), differs from *C. macrocantha* by a shorter filament of the empodium (¾ the length of the inner edge of the claws), by a lower outer lamella on the mucro and by characters which can be the result of evolution in an isolated cave system: very long macrosetae (ratio p_5

Figs 1-8. *Ceratophysella macrocantha* Stach, 1946. (1) Chaetotaxy of antennal segments III and IV, dorsal side. (2) Postantennal organ and adjacent ocelli. (3) Maxillary head, dorsal side. (4) Maxillary head, ventral side. (5) Chaetotaxy of thoracic tergum II. (6) Chaetotaxy of abdominal terga III-VI. (7) Claw III with empodial appendage. (8) Dens and mucro of furca. Scale lines: 1-2; 3-4; 5-6; 7-8 to same scale. Abbreviations: or - subapical organite on antennal segment IV; ms - microsensillum; a_1, a_2, a_3 - setae of a-row; m_2, m_3, m_4 - setae of m-row; p_1, p_2, p_4 - setae of p-row; s - body sensilla; 1, 2, 3, 4, 5, 6 - maxillary lamellae. The longitudinal axis of the body is indicated by a broken line. ▶



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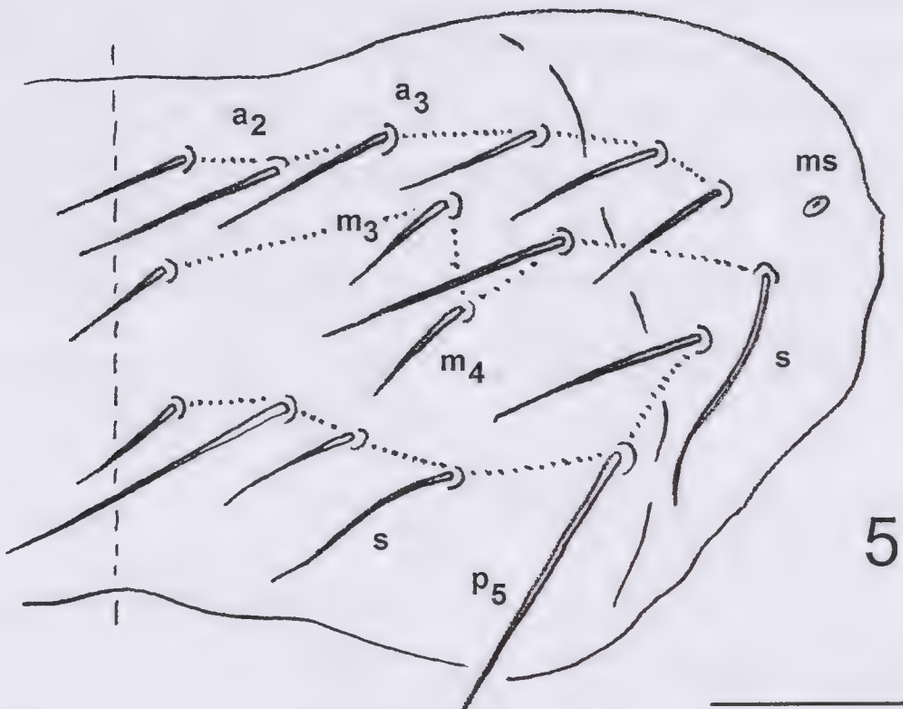

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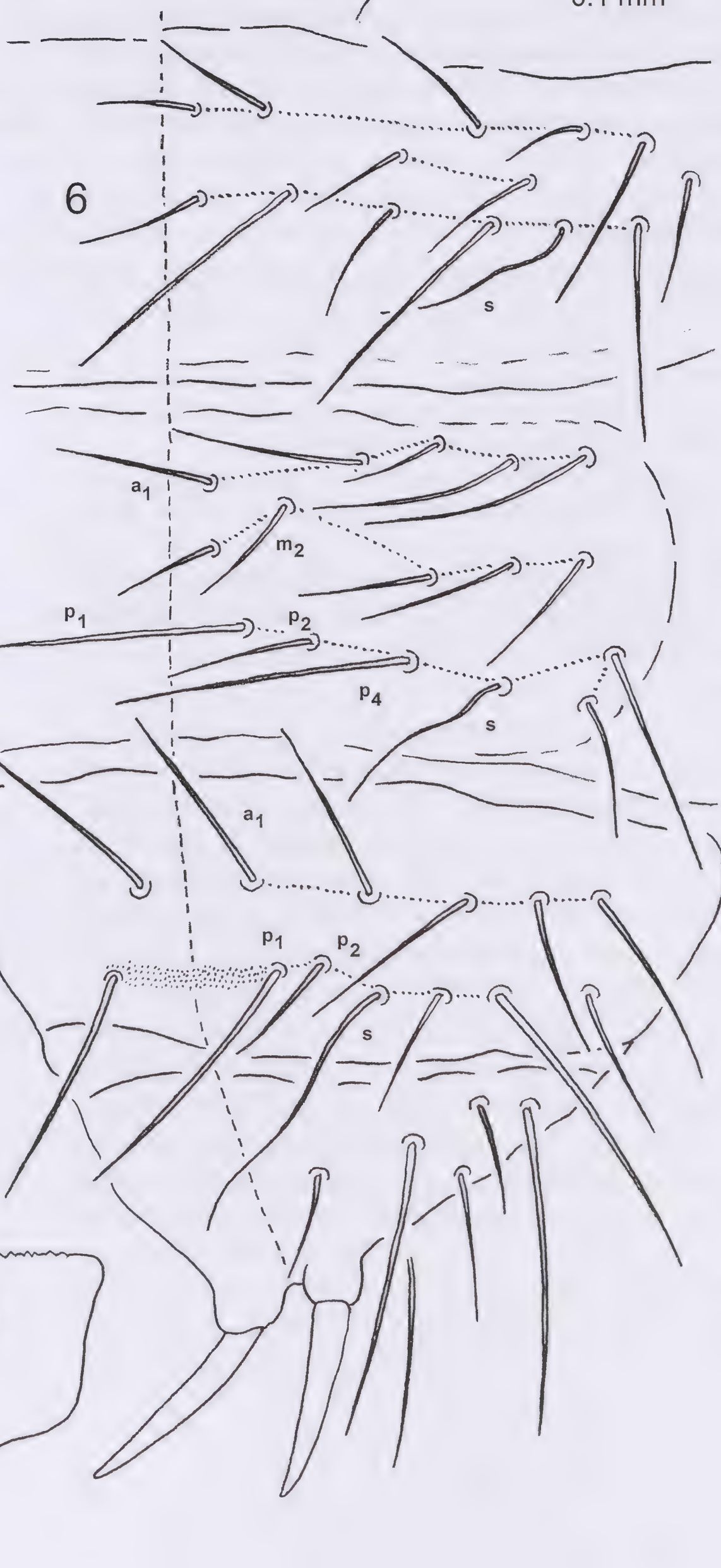

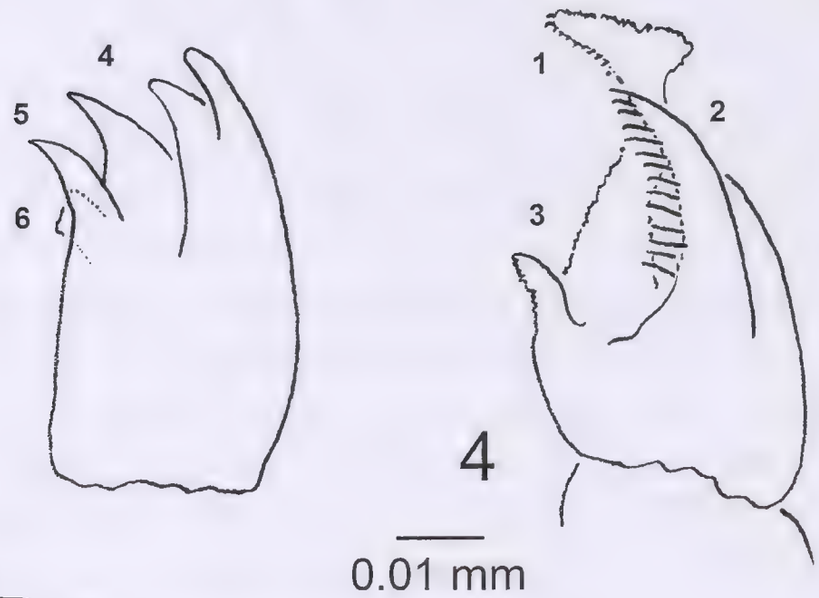

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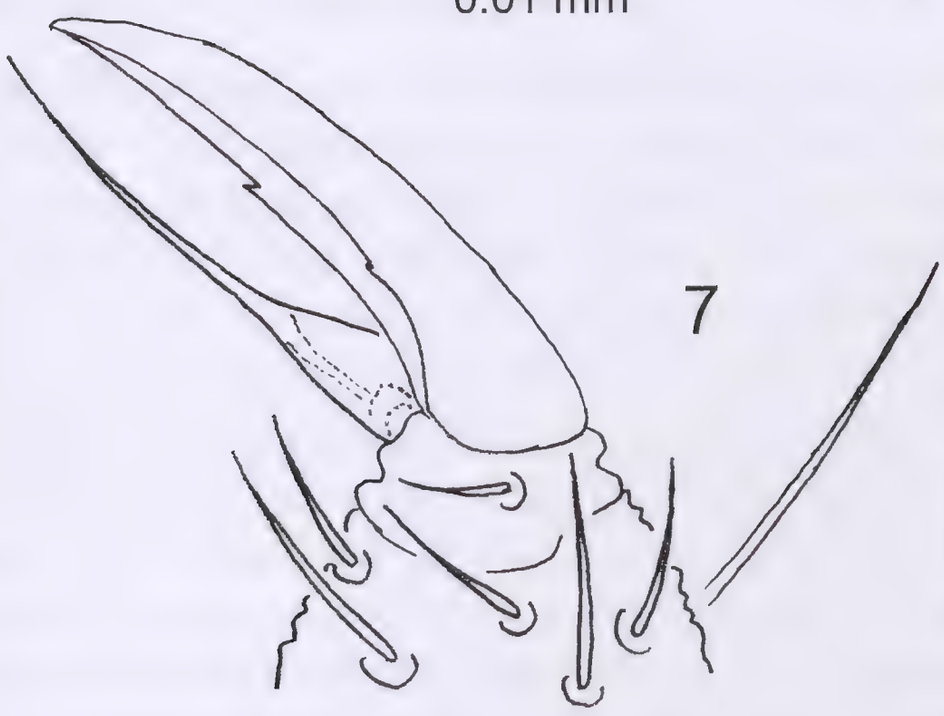

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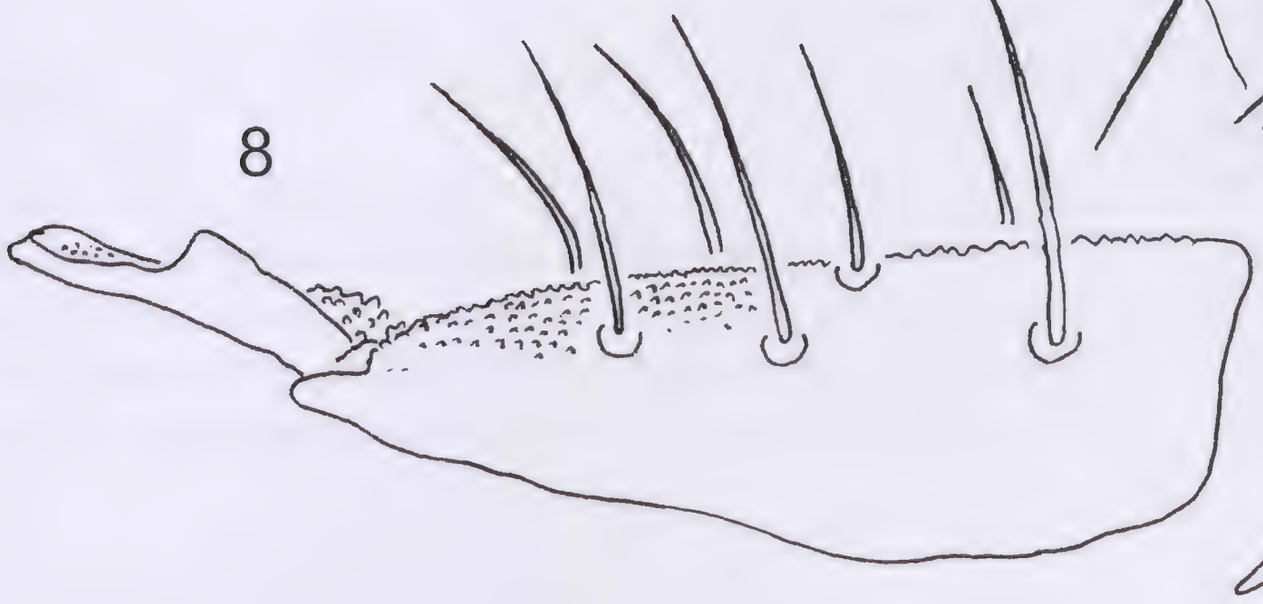

on abdominal tergum II/inner edge of claws III = 2.5), slightly enlarged and modified postantennal organ (ratio postantennal organ/nearest ocellus = 3, presence of a single small finger-like papilla on one of the four primary lobes) and reduced body pigmentation (only blue-black spots present). To clarify taxonomic relations between these three species/forms further research based on more extensive material is needed.

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A synopsis of the ecology of Protura (Arthropoda: Hexapoda)

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Abstract: This publication reviews the literature on the ecology of Protura. Current knowledge is scarce, fragmentary and scattered among papers which do not all strictly deal with ecology or soil arthropods communities. Therefore all available information is summarized in order to better understand the ecology of these arthropods. The density of Protura ranges from hundreds to thousands of individuals per m^2. Their aggregate distribution is probably related to food (fungal hyphae) availability and quality, and to the production of aggregation pheromones. Protura tend to form species assemblages characterizing different habitats. Their populations often show an unbalanced sex ratio in favour of females, suggesting that a single male can fertilize several females, perhaps via spermatophores. For some species only females have been collected, which suggests the possibility of parthenogenesis. Our analysis of the available information on phenology and population dynamics of Protura points toward annual cycles with one, two or more peaks of reproductive activity.

Keywords: Soil - density - habitat - species assemblages - phenology.

MORPHOLOGY AND TAXONOMY

Protura are entognathous Hexapoda living in the soil. They have a tiny body size (range about 0.7-2.5 mm). Due to their unpigmented cuticle proturans are normally whitish or pale yellow; only Sinentomidae are reddish-brown. Protura have no eyes and antennae, but instead they possess a pair of pseudoculi on the head, and a pair of well-developed sensilla-bearing forelegs, which are directed forward and serve as main sensory organs (see Nosek, 1973; Hädicke *et al.*, 2015) (Fig. 1). Meso- and metanotum are equipped with a rudimentary tracheal system in Eosentomata and Sinentomidae. The abdomen has 12 segments; the first three each carry a pair of latero-ventral appendages, which can be one- or two-segmented, furnished with one to five setae. In Acerentomata and Sinentomata the abdomen has pectinate structures. On the abdominal segment VIII of the Acerentomata a so-called "striate band" is present and more or less distinctly developed.

Since their description by Silvestri (1907) many taxonomic papers have been published on Protura [for a detailed historical review on this subject see Pass & Szucsich (2011) and Galli *et al.* (2018)], among them some relevant monographs which deserve specific mention. In 1964 Tuxen published his seminal work about Protura of the World; in 1973 Nosek's monograph on European Protura appeared; Imadaté's book about Japanese species was printed in 1974; and Yin published her monograph about Chinese Protura in 1999. Nevertheless, Protura still remain one of the less known hexapods, especially from a biogeographical, ecological and systematic viewpoint.

Protura was for a long time known as an order belonging to the class Insecta, but since Yin (1984; see also Szeptycki, 2007) they are considered a separate class belonging to the superclass Hexapoda. They are widely distributed, globally with more than 800 species (748 were listed by Szeptycki, 2007) arranged in three orders, seven families and 76 genera (for more information see Galli *et al.*, 2018; Carapelli *et al.*, 2019). The order Acerentomata includes the families Hesperentomidae, Protentomidae and Acerentomidae; the order Sinentomata includes the Fujientomidae and Sinentomidae; the remaining two families, Eosentomidae and Antelientomidae, belong to the order Eosentomata. A key to the orders and keys to the families are provided below.

Note: the authorities of species and other taxon names and their references are not given in this work, but can be found in Szeptycki (2007).

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Key to orders

1A All three pairs of abdominal appendages two-segmented, with a terminal vesicle and five setae ..... **Eosentomata**
1B Abdominal appendages I two-segmented with a terminal vesicle and three to four setae; those on abdominal segment II and III two-segmented, with a terminal vesicle and three to four setae, or uni-segmented, without vesicle and with one to three setae **2**
2A Median setae present on meso- and metanotum ..... **Acerentomata**
2B Median setae absent on meso- and metanotum ..... **Sinentomata**

Key to Acerentomata families

1A Only abdominal appendages I two segmented 2
1B Abdominal appendages I and II two-segmented 3
2A Sternite VIII with two anterior and four posterior setae: formula 2/4 ..... **Hesperentomidae** (part)
2B Sternite VIII never with 2/4 setae, normally with four anterior and none or two posterior setae: formula 4/0 or 4/2 ..... **Acerentomidae**
3A All three pairs of abdominal appendages two-segmented with a terminal vesicle and four setae 4
3B Abdominal appendages I and II two-segmented with a terminal vesicle and three to four setae, appendages III uni-segmented without terminal vesicle and with two to three setae 5
4A Labial palps with tuft of setae, three distinct setae and basal sensillum; pseudoculi with a large triangular prolongation in the proximal part ..... **Protentomidae** (part)
4B Labial palps with tuft of setae and three distinct setae, but without basal sensillum; pseudoculi pear-like, strongly elevated and with a median S-shaped cleft ..... **Hesperentomidae** (part)
5A Abdominal sternites II-VI all with an even number of posterior setae (seta Pc always absent) ..... **Hesperentomidae** (part)
5B An odd number of setae in the posterior row (seta Pc present) of at least one of the abdominal sternites II-VI ..... **Protentomidae** (part)

Key to Sinentomata families

1A Spiracles on meso- and metanotum absent ..... **Fujientomidae**
1B Spiracles on meso- and metanotum present ..... **Sinentomidae**

Key to Eosentomata families

1A Spiracles on meso- and metanotum absent ..... **Antelientomidae**
1B Spiracles on meso- and metanotum present ..... **Eosentomidae**

Protentomidae, Acerentomidae and Eosentomidae are the most species-rich families and their distribution is cosmopolitan. Hesperentomidae, Fujientomidae, Sinentomidae and Antelientomidae are distributed throughout the Oriental and the Holarctic regions. The first of these four families has a wide range and is represented by the genus *Hesperentomon* in East and Central Asia, and in North America, and by the genus *Ionescuellum*, which is endemic to Europe. The other three families with only one genus each occupy smaller areas in Eastern Asia.

FOREWORD ON ECOLOGY

Protura are part of the soil mesofauna. Based on their adaptation to life in the soil and in soil-like substrates, and on their morphological features (e.g. absence of eyes and of pigmentation), Rusek (2007) classified them as Euedaphobionts. Their distribution seems to be limited only by the presence of a sufficient moisture level in the soil to allow the growth of any kind of vegetation, or by the availability of deposits of decaying organic matter (Nosek, 1975).

Protura are generally poorly known and few studies have specifically focused on their ecology. Most field work has involved studying individual habitats and/or small areas (Raw, 1956; Szeptycki, 1969; Von Neuherz & Nosek, 1975; Stumpp, 1990; Szeptycki & Sterzyńska, 1995; Christian & Szeptycki, 2004; Mitrovski Bogdanović & Blesic, 2011). Only in a few cases has ecological information about Protura been inferred on a large geographical scale based on statistical analyses of national or regional species distribution (e.g. Imadaté, 1973, 1974; Szeptycki *et al.*, 2003; Galli *et al.*, 2019). Moreover, there are few synthesis papers on this subject, and often they are not particularly detailed (e.g. Nosek, 1975, 1982).

The current knowledge about the ecology of Protura is scarce, fragmentary and scattered among papers about proturans that often are not strictly dealing with ecology or that are about soil communities in general. This paper

Fig. 1. *Acerentomon italicum* (SEM-micrographs). (A) Lateral view of whole specimen. (B) Detail of rostrum and entogathous mouthparts in frontal view. (C) Detail of anterior part of body with typical position of front legs directed forward as main sensory organs. Scale bars: 100 μm (A) and (C), 20 μm (B).

summarizes almost all relevant data available from the literature in order to better understand the ecology of these arthropods.

DENSITY AND DISTRIBUTION PATTERN

The density of Protura in soils ranges from some hundreds to a few thousand individuals per m². For example, during an investigation carried out in the eastern Italian Alps, in two subalpine spruce (*Picea abies*) forests growing on a calcareous bedrock, Salmon *et al.* (2008a, b) found up to 5456.3/m² (the maximum in 25 years old regeneration south-facing stands). Menta *et al.* (2015) reports a maximum spring density of 297/m² in a kiwi (*Actinidia deliciosa*) plantation and a maximum autumn value of 467/m² both in brush-wood and grassland. In differently managed vineyards Gagnarli *et al.* (2015) recorded an estimated maximum value of 4000-5000/m² during March in organic enriched soils. In soil samples collected in Liguria (NW-Italy) Galli *et al.* (2019) estimated a mean density value of 372.2 [the maximum of 2790/m² in a holm oak (*Quercus ilex*) forest]. For other areas in Europe densities ranging between 6300/m² in mixed oak-hornbeam (*Quercus* spp. - *Carpinus betulus*) forests in the Little Carpathians and 9600/m² in fir (*Abies* spp.) forests in Denmark are summarized by Nosek (1975). In temperate and boreal forests of Europe the density of Protura has been found to range from 1500 to 3900 /m² in spruce forests in Finland (Huhta & Koskenniemi, 1975). Higher density values have been recorded in forests of spruce (Gunnarsson, 1980) and Scots pine (*Pinus sylvestris*) (Axelsson *et al.*, 1973): 8400/m² and 11,400-16,000/m², respectively. More recently, Sterzyńska *et al.* (2012) detected mean densities of nearly 1200/m² in not inundated oak woods and more

than 560/m² in inundated poplar (*Populus* spp.) woods in a Ukrainian river floodplain. The maximum value of Protura density estimated to date is over 90,000/m². This occurred in August in a spruce forest characterized by young plants recovering after a windfall (Krauss & Funke, 1999). However, in 28 spruce forests studied in Germany (Fig. 2A) the average density values ranged between 233 and 15,663/m² (but mostly less than 5000/m²) (Stumpp, 1989). This corresponds with the results obtained by Salmon *et al.* (2006) in regeneration stands of spruce forests in Norway. Some authors have found that proturans densities are higher in coniferous forests than in broadleaf forests (e.g. Gunnarsson, 1980), but it is important to point out that, especially under the Mediterranean climate (see paragraph "Altitudinal and vertical distribution"), population densities can be strongly influenced by seasonal climate. A good example is the gap between the July and February densities of Protura in the *Pinus halepensis* forest of Mt Carmel (Israel): 340/m² and 3910/m², respectively (Broza *et al.*, 1996).

Protura usually show an aggregate distribution. This phenomenon has been observed by some authors in different countries. For example, by Raw (1956) during his research on grasslands of Rothamsted Park Grass (UK), by Walker & Rust (1975) in three forests in Delaware, by Gunnarsson (1980) who studied the distribution and abundance of Protura in an oak wood and a spruce stand in SW Sweden, and most recently by Galli *et al.* (2019) in different habitats in Liguria (NW-Italy). This kind of distribution is quite common among soil arthropods (see Wardle, 2002) and it is thought to be due to environmental pressures and/or to the production of aggregation pheromones. For example, several species of springtails show aggregate distributions and are known to produce aggregation pheromones for sexual attraction as well to foster grouping at rich food sources. Dense aggregation may also allow Collembola to create their own ideal microclimate and prevent desiccation (see Hopkin, 1997).

Fig. 2. Habitats of Protura. (A) An example from the Zittauer Gebirge (Germany) of the habitat with the highest recorded Protura densities, the spruce (*Picea abies*) forest (photo: B. Lang). (B) Understory of tree ferns in a regenerating podocarp (*Podocarpus* spp.) forest near the Blue Lake, Rotorua, New Zealand (photo: A. Murray). (C) Cork oak (*Quercus suber*) forest in Bergeggi (NW-Italy), one of the most studied places for soil arthropods in the Mediterranean region (photo: L. Galli). (D) Soil surface in downy oak (*Quercus pubescens*) stand over platy marl (390 m elev.) in the Wienerwald harbouring record number (23) of syntopic species (photo: E. Christian).

EDAPHIC FACTORS

Galli *et al.* (2019) analysed data collected in chestnut (*Castanea sativa*) and beech (*Fagus sylvatica*) forests on three mountains close to each other in Liguria (NW-Italy), deducing that vegetation and physico-chemical characteristics of the soils on different geological substrates (pH and granulometry) may influence Protura density. In particular, they evidenced a negative correlation between pH values and proturan densities (both log transformed) that, however, cannot be generalized. Minor (2008), analysing Protura in New Zealand forests (Fig. 2B), was unable to find any correlation between their density and soil physico-chemical properties (organic matter, nitrogen, phosphorous, pH, cation exchange capacity). The absence of a direct correlation between abundance of soil microarthropods and soil chemistry seems to be common (Laiho *et al.*, 2001). On the other hand, da Silva *et al.* (2016) found a negative correlation between pH and springtail richness, identifying soil pH as the main parameter influencing Collembola communities. Furthermore, Maraun & Scheu (2000) showed an indirect influence of pH on the density of oribatid mites. Soil acidity affects the humus form via modifying macrofauna-mediated processes (litter fragmentation and bioturbation), determining changes from a moder (preferred by oribatids) to a mull humus.

For information about the response of Protura to treatments with chemical pollutants we refer to Stumpp (1989) who evidenced a differential decrease of proturan densities following the exposure to different toxic substances.

ALTITUDINAL AND VERTICAL DISTRIBUTION

Protura can be collected in several different habitats (see for example Nosek, 1973) at elevations ranging from the sea level to the treeless zone on high mountains. At the moment the altitudinal records are held by *Delamarentulus tristani* at 3500 m elev. in the Andean pàramos (Tuxen, 1978) and by *Eosentomon validum* in the Rwenzori Mountains, Uganda, near the Bujuku Lake, at about 4000 m elev. (Condé, 1961). For an interesting study on the altitudinal succession of Protura species assemblages on the slope of a mountain, from 400 to 2000 m elev., we refer to Nakamura (1989).

Tuxen & Imadaté (1975), Shrubovych & Sterzyńska (2017) and Galli *et al.* (2019), studying Protura distribution in the Bismarck Archipelago and Solomon Islands, in the Ukraine and in Italy, respectively, observed that species occurring at higher elevations tolerate a wider range of climatic and ecological conditions and so have generally large geographical ranges. This accords with Rapoport's altitudinal rule (see Gaston *et al.*, 2008).

Information on the vertical distribution of Protura in soils is rather limited, with higher densities recorded in the first few cm (topsoil). Samples taken at different localities in Austria (Franz *et al.*, 1969) showed the highest concentration of proturans in the top 10 cm. On Hokkaido, Imadaté (1974) found that 90% of all Protura were in the top 8 cm of soil, and only *Hinomotentomon nipponicum* was collected at depths greater than 12 cm (up to 38 cm). Condé (1960) found *Proturentomon picardi* at a soil depth of 50 cm. From California (in a pine forest and in an agricultural habitat) Price (1975) and Price & Benham (1977) recorded the presence of Protura at even greater depths. Moreover, Stumpp (1989) showed the differential vertical distribution of four species of Protura, and Nosek (1975) observed the adaptive tendency that Protura living deep in the soil have smaller bodies with shorter legs. These Protura (e.g. *H. nipponicum* and some species of *Proturentomon*, *Protentomon* and *Condeellum*) also have short bacilliform or foliaceous foretarsal sensilla. Conversely, species living closer to the soil surface are generally slender and long, with longer legs, and have long and/or large foretarsal sensilla. In this context it deserves to be mentioned that Fratello & Sabatini (1979) found a positive correlation between a higher chromosome number and a smaller foretarsus.

In the Mediterranean and in other temperate areas Protura probably move up and down the soil profile in response to temperature and moisture levels. Galli *et al.* (2012) recorded that seasonal fluctuations of Protura populations in the soil of a cork oak wood (*Quercus suber*) near Bergeggi (NW-Italy; see Fig. 2C) are linked to a decrease in the number of individuals close to the soil surface during the summer drought. Similarly, in an oak forest in Serbia, Mitrovski Bogdanović & Blesic (2006, 2011) detected two periods of decline in proturan abundance (the first in winter-early spring, the second in August) due to the migration of individuals into soil layers deeper than 20 cm in order to avoid the direct influence of environmental factors such as adverse soil temperatures, moisture levels, increased number of predators and competitors, etc. A migration towards deeper soil levels during the warm season was also hypothesized by Price (1975) on the basis of results of his study in a California pine forest. In addition, Malmström (2008) demonstrated that many soil organisms (Protura included) do not survive temperatures higher than 36°C: in warmer regions this feature could induce migration to a greater depth. Nakamura (2013) evidenced a seasonal migration of *Eosentomon sakura* and *E. impar* from the soil surface (0-5 cm) down to 25-30 cm depth, probably in order to avoid severe cooling during winter. Balkenhol (1994, 1996) showed that *Acerentomon nemorale* could cover relatively large distances (maximum 80-90 cm in six days at 15°C) under laboratory conditions, but her field studies did not show any significant movement, which she assumed was due to the Protura entering into a state of torpor in response to changing and adverse soil temperature and moisture conditions. Many species of Collembola become dormant or quiescent in response to low relative humidity, and the majority of species

in the Provence (France) survive the dry summer as eggs which are resistant to desiccation (see Hopkin, 1997). Furthermore, Choi *et al.* (2006) demonstrated that for *Paronychiurus kimi* major limiting factors are soil moisture levels and seasonal rainfall patterns, and that there is a significant reduction of fecundity under moisture stress.

DISTRIBUTION AND ECOLOGY

Nosek (1973, 1975, 1982) noted that European Protura form relatively stable community associations in different types of forests, presumably due to species having similar environmental requirements. Minor (2008) observed that Protura assemblage composition in New Zealand was significantly related to forest type. She also deduced that proturan abundance patterns might reflect an association with fungal communities in the soil. Similarly, Galli *et al.* (2019) outlined genera (and sometimes species) assemblages typical of some macro-habitats represented in Italy and Corsica. However, after in-depth data analyses of studies on Japanese Protura, Kaneko *et al.* (2012) concluded that vegetation was not responsible for their distribution. Assemblages characterizing different areas should be considered the result of historical waves of immigrations ("invasions") of Protura and of the current climate (temperature and rainfall). After all, Tuxen (e.g. 1977, 1978) had already highlighted the importance of biogeographical factors with respect to habitats in the distribution of Protura species.

In some studies a relationship between the ecological adaptability of species and the size of their geographical range was found. For the European Protura Nosek (1975) observed that there are species (e.g. *Eosentomon transitorium* and *Proturentomon minimum*) which have a wide range and are euryoecious, whereas other species are confined to smaller ranges and are less able to tolerate varying ecological conditions, often being restricted to natural habitats characterized by a luxuriant vegetation. Galli *et al.* (2019) found a positive linear relationship between the geographical distribution of the species in Italy and their ecological adaptability (number of habitats colonized).

The species richness of Protura for each sampled locality was studied for many sites in different countries. For example, Imadaté (1970) recorded 6-10 species/locality in natural forests of the lowlands in central Honshu, while 1-13 species/locality were collected in the whole of Japan (Kaneko *et al.*, 2012); Germany has 1-6 species at various sampling sites in spruce forests (Stumpp, 1990); 1-8 species were found in meadow soils in Serbia (Blesic, 2005) and in river floodplain forests of Ukraine (Sterzyńska *et al.*, 2012), and 1-11 species per site in Italy (Galli *et al.*, 2019). Christian & Szeptycki (2004) recorded 23 syntopic species in a *Quercus pubescens* stand over platy marl (390 m elev.) in the Wienerwald (Fig. 2D), which to date is the maximum number of species recorded from one sampling area.

Some authors (e.g. Blesic, 2002, 2004; Galli *et al.*, 2019) observed that Protura assemblages in forest soils are characterized by a greater abundance and diversity than those in meadow soils. Particularly high densities have been recorded in coniferous forests (see paragraph "Density and distribution pattern").

Some studies have focused on the faunal composition of Protura in urban areas and shown that some species are more tolerant to an urban environment than others. Szeptycki *et al.* (2003) found a very specific fauna in town parks, gardens and other anthropogenic habitats in Luxemburg. Some species such as *Acerentulus cunhai* and *Gracilentulus gracilis* are much more common in urban habitats than in natural habitats. For example, *Proturentomon discretum*, *Berberentulus polonicus* and *Eosentomon luxembourgense* were only found in towns. Conversely, some species (*Acerentomon nemorale*, *A. brevisetosum*, *Acerella remyi*, *Eosentomon silesiacum* and *E. stompi*) have not been found in anthropogenic habitats. Christian & Szeptycki (2004) described the species distribution along an urban gradient in Vienna, pointing out that some species (*E. luxemburgense* and *E. mirabile*) seem to be particularly tolerant of, and adapted to, anthropogenic habitats. Galli *et al.* (2019) observed that dominant species in urban habitats in Italy (i.e. *Acerentomon italicum*, *A. microrhinus* and *Acerentulus confinis*) were among the most common, widespread, and adaptable species in Italy. Imadaté & Ohnishi (1993) noted that the Japanese Protura comprise a southern and a northern group of species, and that members of the southern group are more tolerant to habitat degradation and urbanization. Nakamura (2014) confirmed such conclusions citing that *Eosentomon sakura*, *Paranisentomon tuxeni* and *Eosentomon tokiokai* (representatives of the southern group) were collected from soils of almost the same vegetation types in rural and urban areas, suggesting that they tolerate urbanization. *Eosentomon sakura* is particularly dominant in areas with low plant diversity and/or with lush vegetation such as young secondary forests, plantations, parks, etc., and remains largely unaffected by urbanization, thus demonstrating a high tolerance towards anthropogenic influence. *Paranisentomon tuxeni* and *E. tokiokai* prefer evergreen broadleaved forests and evergreen coniferous forests in rural and urban areas, respectively. In contrast, *Eosentomon asahi* (a species of the northern group) occurs mainly in deciduous broadleaved forests and plantations. It is less abundant in urban areas, which is probably due to its low capability to adapt to such an environment. This is not surprising given that Imadaté (1970) found this species to be extremely sensitive to environmental changes, disappearing soon after deforestation took place.

Small mammal nests are examples of another habitat where Protura have been collected. In the western

Carpathians *Acerentomon dispar* and *A. nemorale* were collected from the nests of *Apodemus flavicollis* and *Myodes glareolus*, respectively (Nosek *et al.*, 1978). Galli *et al.* (2019) identified *Acerentomon microrhinus* from a Mole (*Talpa* sp.) nest in Italy.

TROPHIC LEVEL

Protura are secondary consumers in the decomposition subsystem of terrestrial ecosystems. They are part of the detritus-based food web and depend on the energy obtained from feeding on fungal hyphae (the so called "fungal energy channel" – see Wardle, 2002) (Fig. 3). Their mouthparts are well adapted to sucking. Sturm (1959) reported *Acerentomon* sp. and *Eosentomon transitorium* feeding on beech ectomycorrhizal fungi (EMF). Likewise, Stumpp (1990), studying Protura population dynamics in spruce forests in Germany, concluded that specimen numbers correlated positively with the abundance of EMF. Malmström & Persson (2011) tested Stumpp's hypothesis via tree-girdling experiments in *Picea abies* and *Pinus sylvestris* forests in northern Sweden. Tree girdling was assumed to stop the flux of carbohydrates to roots and associated fungi, thereby inhibiting growth and long-term survival of EMF. About one year after girdling proturan abundance decreased, indicating that they prefer feeding on EMF. Similarly, Sterzyńska *et al.* (2012) observed that differences in the distribution patterns of Protura assemblages in a Ukrainian river floodplain were highly correlated to the frequency of available ectotrophic mycorrhizae. They noted that the transition from early successional stages of riparian forests, where regular flooding promotes arbuscular mycorrhizal fungi, to older stages, where EMF are more common, was associated with an increase in Protura abundance and diversity. In a study using three *in situ* analytical methods (stable isotope labelling, neutral lipid fatty acid analysis and natural variations of stable isotope ratios) Bluhm *et al.* (2019) showed that *Acerentomon gallicum* predominantly feeds by sucking up hyphal cytoplasm of EMF.

Machida & Takahashi (2004) reared proturans and observed that they often gathered around the "bush" of mycelia or mycelial strands. Individuals were sometimes observed inserting their rostrum into mycelia, presumably to feed on fungal protoplasm. These observations suggest that not all Protura species are strictly depending on EMF but can also feed on "free" hyphae. Nosek (1975) and Balkenhol (1994) came to the same conclusion by studying several species. Moreover, Kaneko *et al.* (2012) compared proturan assemblages in broadleaved forests with those in conifer forests of Japan, in which mycorrhizal species composition differed, but they did not find any clear response from Protura to different vegetation types. Therefore they rejected the hypothesis that there is a strong link between proturans and mycorrhizal fungal species.

Protura are probably the prey of other small arthropods like mites and other tiny arachnids. When analysing the behaviour of an *Acerentulus confinis* specimen, Hansen *et al.* (2010) observed a possible defence mechanism when the animal released a sticky exudate from the large gland openings on the eighth abdominal segment. When applied to the mouthparts of a small predator, such an exudate may prevent further aggression.

Fig. 3. *Acerentomon* specimen feeding on the ground of a beech (*Fagus sylvatica*) forest near East Pennard, UK (photos: A. Murray). (A) Whole animal. (B) Detail of anterior part of body (legs and rostrum clearly visible).

POPULATION DYNAMICS (PHENOLOGY AND SEX RATIO)

The phenology of Protura has not been the focus of much research. The scarcity of records of juveniles, a phenomenon already pointed out by Walker & Rust (1975), makes it difficult to identify well defined phenological patterns useful for determining the life cycles of the majority of species. The first substantial data available in the literature were those about populations of Protura in soils supporting a mixed evergreen-deciduous forest in Tokyo (Imadatè, 1974). Imadatè documented different patterns of seasonal fluctuations in the collected species: a double-peaked pattern (maxima in spring and in autumn) in *Eosentomon sakura*, a single-peaked pattern (maximum in autumn) in *E. kumei*, *Baculentulus morikawai*, *B. tosanus*, *Kenyentulus japonicus* and *Nippoentomon nippon*, and an almost constant density all

year round in *E. asahi*. Similar patterns have subsequently been described by other authors (e.g. Stumpp, 1989; Balkenhol, 1994; Szeptycki & Sterzyńska, 1995), and one of the most interesting results that emerges from the comparison of different studies is that phenology of the same species can vary in different areas, probably in response to the different local climates. For example, in a study in Italy, Galli *et al.* (2016) recorded that in *Acerentomon italicum* populations juveniles were present every month in Liguria and Tuscany, but only during spring and summer in the remaining regions of northern Italy. Interestingly, Galli *et al.*, 2019 described a double-peaked phenology for *Acerentomon gallicum* in Italy, which differs significantly from the three-peaked phenology described for *A. gallicum* in Germany by Balkenhol (1994). Similarly, Mitrovski Bogdanović & Blesic (2011) described a double-peaked phenology (September and June-July) for *Eosentomon transitorium* in an oak forest dominated by *Quercus conferta* and *Q. cerris* in Serbia, which is quite different from the trend observed for this species in Italy by Galli *et al.* (2019). There two maxima of juveniles were recorded in March and from June to August (adults showing a third peak in October, when no juveniles were collected).

Another interesting feature of Protura populations is that they commonly have an unbalanced sex ratio in favour of females. This can be deduced by analysing various faunal studies (e.g. Nosek, 1973) and has been explicitly pointed out for different species by several authors. Amongst others, Gunnarsson (1980) recorded that females of *Eosentomon germanicum* in an oak wood in Sweden were more than twice as numerous as males, and Galli *et al.* (2019) observed a similar bias in 12 Acerentomata species in Italy. On the basis of the sperm structure of Protura (see Dallai *et al.*, 2010a, b), Galli *et al.* (2019) hypothesized that this imbalanced sex ratio could be related to indirect sperm transfer through spermatophores as one of the possible mechanisms which enables a single male to fertilize more females.

Some authors recorded the absence of males in populations of Protura: for example Tuxen (1967, 1985) found only females in some Australian and New Zealand species. More recently, Minor (2008) detected four species in New Zealand in which the populations were devoid of males. Shrubovych *et al.* (2014) and Galli (in Galli *et al.*, 2019) examined many specimens of *Andinentulus rapoporti* from Chile and found only females. The latter authors recorded only females in Italian populations of *Proturentomon minimum*. Though parthenogenesis in Protura has never been confirmed experimentally, the information mentioned above suggests that at least in some populations of certain species, parthenogenesis may occur.

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The *Pselaphodes* (Coleoptera: Staphylinidae: Pselaphinae) of Nepal

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Abstract: The genus *Pselaphodes* Westwood, 1870 is poorly known from the Himalayas, and represented in Nepal by a single species. In this paper 15 new Nepalese species are described: *P. ampliatus* sp. nov., *P. bagmatius* sp. nov., *P. bilobatus* sp. nov., *P. corniger* sp. nov., *P. coxatus* sp. nov., *P. khandbarius* sp. nov., *P. loebli* sp. nov., *P. procerus* sp. nov., *P. psomus* sp. nov., *P. robustus* sp. nov., *P. rotundatus* sp. nov., *P. sagephorus* sp. nov., *P. smetanai* sp. nov., *P. symmetricus* sp. nov., and *P. tmesisternus* sp. nov. Main characters distinguishing species include secondary sexual characters of males and morphological differences in the aedeagi. New collecting records for *P. unicornis* Bekchiev & Hlaváč, 2013 in Nepal are given. *Pselaphodes spinosus* Champion, 1925, previously known from northern India and southwestern China, is newly recorded from Nepal.

Keywords: Taxonomy - *Pselaphodes* - new species - new records - Nepal.

INTRODUCTION

The genus *Pselaphodes* Westwood, 1870 of the tribe Tyrini is the largest group of the Oriental *Pselaphodes*-complex formed by nine morphologically similar genera (sensu Hlaváč, 2003; key to genera also see Yin *et al.*, 2013a). A total of 65 species have been previously described from the Philippines (1 sp.), East Malaysia (1 sp.), Thailand (2 spp.), Sri Lanka (1 sp.), India (2 spp.), Nepal (1 sp.), and China (58 spp.) (Huang *et al.*, 2018b). Most species of this group were described during the last decade (Bekchiev & Hlaváč, 2013; Yin *et al.*, 2010, 2011, 2012a, b, 2013a, b; Yin & Li 2012, 2013; Huang *et al.*, 2018a, b), and some taxonomic confusion has been recently clarified (Yin & Li, 2015).

The *Pselaphodes* fauna of the Himalayan region is poorly understood due to the lack of taxonomic treatments. To date, only a single *Pselaphodes* species has been described from Nepal (Bekchiev & Hlaváč, 2013). Here, we describe fifteen new Nepalese species of the genus based on an examination of the large pselaphine collection deposited in the Muséum d'histoire naturelle, Geneva. In addition, new collecting records of the previously described *P. unicornis* Bekchiev & Hlaváč, 2013, and a new country record for *P. spinosus* Champion, 1925 are provided. Accordingly, the total species number of *Pselaphodes* now reaches 80.

MATERIAL AND METHODS

The material used in this paper is housed in the Muséum d'histoire naturelle, Geneva, Switzerland (MHNG), the National Museum of Natural History, Sofia, Bulgaria (NMNHS), the Insect Collection of Shanghai Normal University, Shanghai, China (SNUC), and the Institute of Zoology, Chinese Academy of Sciences (IZ-CAS). In most cases, the text of the specimen labels is quoted verbatim in quotation marks (‘ ’). For the type localities, an interpretation of the locality data is given.

Dissected parts were preserved in Euparal on plastic slides that were placed on the same pins with the specimens. The habitus images were taken using a Canon 5D Mark III camera with a Canon MP-E 65 mm f/2.8 1-5X Macro Lens, and a Canon MT-24EX Macro Twin Lite Flash used as the light source. Images of the morphological details were produced using a Canon G9 camera mounted to an Olympus CX31 microscope under transmitted light. Zerene Stacker (version 1.04) was used for image stacking. All images were modified and grouped into plates in Adobe Photoshop CS5 Extended.

The following acronyms are used in the text:

BL – length of the body (= HL + PL + EL + AL);
HL – length of the head from the anterior clypeal margin to the occipital constriction;
HW – width of the head across eyes;
PL – length of the pronotum along the midline;
PW – maximum width of the pronotum;

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EL – length of the elytra along the suture;
EW – maximum width of the elytra;
AL – length of the abdomen along the midline;
AW – maximum width of the abdomen.

TAXONOMY

Description of new species

***Pselaphodes ampliatus* sp. nov.**

Figs 1A, 2A-L

Type material (7 specimens)**:** Holotype; MHNG-ENTO-43959; ♂; NEPAL, 'NEPAL (Prov. Bagmati), Yangri Ridge, 4350 m, 22.IV.81, Löbl & Smetana'. – Paratypes; MHNG-ENTO-43960 to 43963; 1 ♂, 3 ♀♀; NEPAL, same label data as holotype. – MHNG-ENTO-43964 to 43965; 1 ♂, 1 ♀; NEPAL, same label data as holotype, except '4200 m, 21.IV.81' (all paratypes in MHNG).

Type locality: Nepal, Sindhupalchowk District, Yangri Mountains, 4350 m alt.

Diagnosis of males: Length 2.63-2.76 mm. Antennal clubs lacking modification. Metaventral processes long, apically broadened. Profemora with small ventral projection, protibiae with distinct projection at apex; mesotrochanters with slender ventral spine, mesotibiae with small projection at apex; metafemora broadly thickened ventrally. Median lobe of aedeagus narrowed apically; parameres slender and elongate.

Description: Male (Fig. 1A). Body reddish brown, BL 2.63-2.76 mm. Head slightly longer than wide, HL 0.53-0.55 mm, HW 0.52-0.53 mm; each eye composed of about 26 facets; ocular canthus weak. Antennomeres

Fig 1. Dorsal habitus of *Pselaphodes* males. (A) *P. ampliatus* sp. nov. (B) *P. bagmatius* sp. nov. Scale bars: 1 mm.

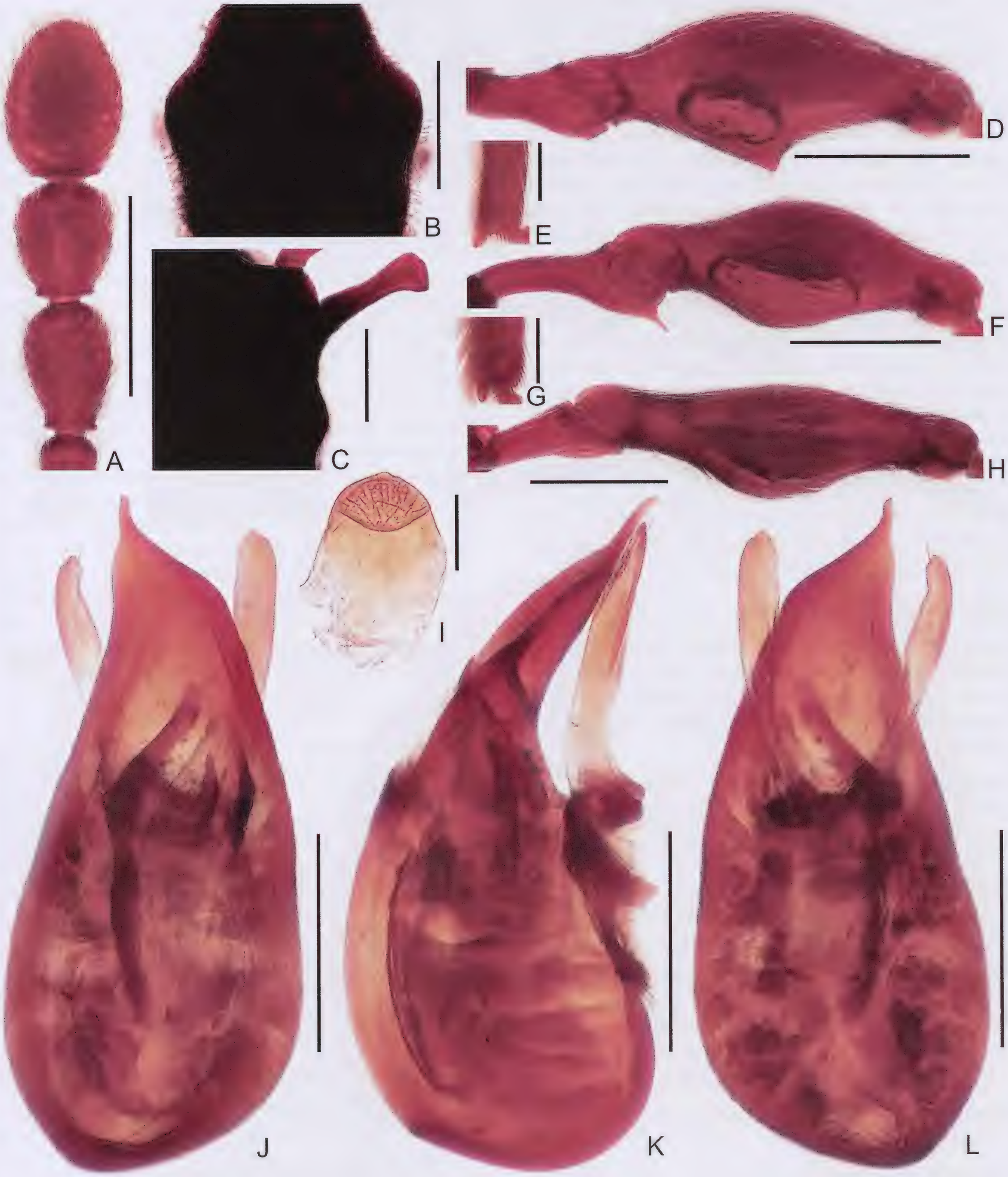

Fig 2. Male diagnostic features of *Pselaphodes ampliatus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

(Fig. 2A) 9-11 forming distinct enlarged club, lacking modification. Pronotum (Fig. 2B) slightly longer than wide, PL 0.59-0.61 mm, PW 0.56-0.59 mm, rounded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.73-0.79 mm, EW 1.11-1.16 mm. Metaventral processes (Fig. 2C) long, apically broadened. Profemora (Fig. 2D) with small ventral projection, protibiae (Fig. 2E) with distinct projection at apex; mesotrochanters (Fig. 2F) with slender ventral spine; mesotibiae (Fig. 2G) with small projection at apex; metafemora (Fig. 2H) broadly thickened ventrally. Abdomen broad at base and narrowing apically, AL 0.78-0.81 mm, AW 1.16-1.17 mm. Sternite IX semi-membranous, shape as in Fig. 2I. Length of aedeagus (Figs 2J-L) 0.61 mm; median lobe asymmetric; apically narrowed, parameres elongate; endophallus composed of one long and one short sclerites.

Female. Each eye composed of about 23 facets; antennae simple. Measurements: BL 2.78-2.80 mm, HL 0.55-0.56 mm, HW 0.53-0.56 mm, PL 0.58-0.64 mm, PW 0.59-0.61 mm, EL 0.74-0.76 mm, EW 1.23-1.32 mm, AL 0.87-0.88 mm, AW 1.23-1.32 mm.

Distribution: Nepal, Bagmati.

Comparative notes: This species can be readily separated from all other congeners from Nepal based on the simple antennal clubs, the apically broadened metaventral processes, and the unique form of the aedeagus.

Etymology: The specific epithet '*ampliatus*' means 'widened, extended, enlarged', referring to the strongly expanded male femora of the new species.

Pselaphodes bagmatius sp. nov.

Figs 1B, 3A-L

Type material (3 specimens)**:** Holotype; MHNG-ENTO-43966; ♂; NEPAL, 'NEPAL (Prov. Bagmati), Malemchi, 2900 m, 14.IV.81, Löbl & Smetana'. – Paratypes; MHNG-ENTO-43967 to 43968; 2 ♀♀; NEPAL, same label data as holotype (MHNG).

Type locality: Nepal, Sindhupalchok District, Melamchi, 2900 m alt.

Diagnosis of males: Length 3.06 mm. Antennomeres 9 with disc-shaped process at apex, antennomeres 10 with small projection at base. Metaventral processes long, apically broadened. Protrochanters with small ventral spine, profemora with big, blunt ventral spine, protibiae with slender spine at apex; mesotrochanters with acute ventral spine, mesotibiae with small projection at apex; metacoxae with sharp ventral spine. Median lobe of aedeagus narrowed apically; parameres slender at base and broadening apically.

Description: Male (Fig. 1B). Body reddish brown, BL 3.06 mm. Head wider than long, HL 0.58 mm, HW 0.62 mm; each eye composed of about 30 facets; with well-developed ocular canthus. Antennomeres (Fig. 3A) 9-11 forming distinct club, antennomeres 9 with disc-shaped process at apex, antennomeres 10 with small, lamina-like projection at base. Pronotum (Fig. 3B) longer than wide, PL 0.68 mm, PW 0.65 mm, rounded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.78 mm, EW 1.20 mm. Metaventral processes (Fig. 3C) long, apically expanded. Protrochanters with small ventral spine, profemora with blunt ventral spine (Fig. 3D), protibiae (Fig. 3E) with slender spine at apex; mesotrochanters (Fig. 3F) with acute ventral spine; mesotibiae (Fig. 3G) with small projection at apex; metacoxae (Fig. 3H) with sharp ventral spine. Abdomen broad at base and narrowing apically, AL 1.02 mm, AW 1.40 mm. Sternite IX semi-membranous, shape as in Fig. 3I. Length of aedeagus (Figs 3J-L) 0.74 mm; median lobe strongly asymmetric, narrowed at apex; parameres narrowed at base and broadening apically; endophallus composed of one elongate and one short sclerites.

Female. Each eye composed of about 30 facets; antennae simple. Measurements: BL 3.14-3.16 mm, HL 0.62-0.65 mm, HW 0.58-0.61 mm, PL 0.68-0.70 mm, PW 0.61-0.67 mm, EL 0.68-0.74 mm, EW 1.34-1.38 mm, AL 1.09-1.14 mm, AW 1.40-1.52 mm.

Distribution: Nepal, Bagmati.

Comparative notes: Among the Nepalese *Pselaphodes*, the males of 15 species (out of 17 spp.) share the following traits: i) a modified base of antennomere 9, ii) a modified apex of antennomere 10, and iii) an endophallus of the aedeagus composed of one long and one short sclerite. These species seem to have undergone a relatively rapid speciation and form a group of putatively closely related species (here termed as '*P. bagmatius* species-group'). *Pselaphodes bagmatius* belongs to this group and can be readily separated from all similar congeners based on the unique spination of the legs, the shapes of the antennal club, the metaventral process, and the aedeagus.

Etymology: The specific epithet refers to the type locality of the new species, *i.e.*, Bagmati Province.

Pselaphodes bilobatus sp. nov.

Figs 4A, 5A-L

Type material (12 specimens)**:** Holotype; MHNG-ENTO-43969; ♂; NEPAL, 'NEPAL, Khandbari District, above Sheduwa, 3000 m, 31.III.-1.IV.1982, A. & Z. Smetana' (MHNG). – Paratypes; MHNG-ENTO-43970 to 43974; 2 ♂♂, 3 ♀♀; NEPAL, same label data as holotype. – MHNG-ENTO-43975; 1 ♀; NEPAL; same label data as for preceding, except '2.IV.1982'. – MHNG-ENTO-43976; paratype, 1 ♂; NEPAL;

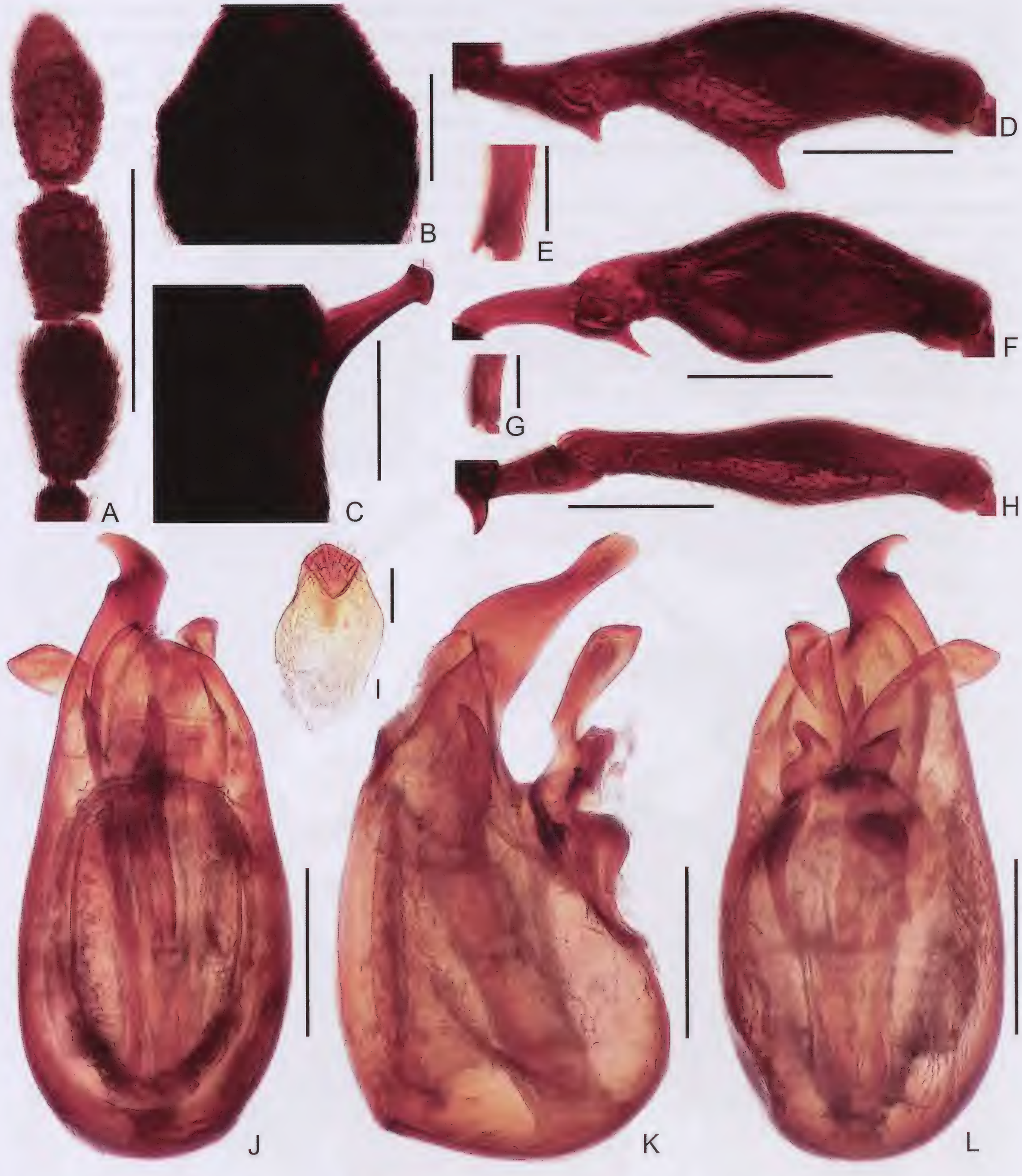

Fig 3. Male diagnostic features of *Pselaphodes bagmatius* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

'NEPAL, Khandbari District, "Bakan" W of Tashigaon 3200 m, 5.IV.1982, A. & Z. Smetana'. – MHNG-ENTO-43977 to 43980; 1 ♂, 3 ♀♀; NEPAL, 'E. NEPAL: KOSI Crête N-E Mangmaya, 2800 m, 7.IV.84, Löbl - Smetana' (all paratypes in MHNG).

Type locality: Nepal, Sankhuwasabha District, Khandbari, 3000 m alt.

Diagnosis of males: Length 3.02-3.29 mm. Antennomeres 9 with projection at apex, antennomeres 10 with projection at base. Metaventral processes long, apically expanded, with additional pair of small triangular projections. Protrochanters with small ventral spine, profemora with large, blunt ventral spine, protibiae with small, blunt projection at apex; mesotrochanters with acute ventral spine, mesotibiae with small spine at apex. Median lobe of aedeagus bifid apically; parameres slender at base and strongly broadened apically.

Description: Male (Fig. 4A). Body reddish brown, BL 3.02-3.29 mm. Head longer than wide, HL 0.65-0.68 mm, HW 0.55-0.64 mm; each eye composed of about 35 facets; with well-developed ocular canthus. Antennomeres (Fig. 5A) 9-11 forming distinct club, antennomeres 9 with projection at apex, antennomeres 10 with projection at base. Pronotum (Fig. 5B) longer than wide, PL 0.59-0.68 mm, PW 0.61-0.62 mm, angularly expanded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.76-0.82 mm, EW 1.06-1.25 mm. Metaventral processes (Fig. 5C) long, apically broadened, with pair of small triangular projection in addition to long

Fig 4. Dorsal habitus of *Pselaphodes* males. (A) *P. bilobatus* sp. nov. (B) *P. corniger* sp. nov. Scale bars: 1 mm.

processes. Protrochanters with small ventral spine, profemora with large, blunt ventral spine (Fig. 5D), protibiae (Fig. 5E) with blunt projection at apex; mesotrochanters (Fig. 5F) with acute ventral spine; mesotibiae (Fig. 5G) with small spine at apex; metatrochanters and metafemora (Fig. 5H) simple. Abdomen broad at base and narrowing apically, AL 1.02-1.11 mm, AW 1.09-1.40 mm. Sternite IX semi-membranous, shape as in Fig. 5I. Length of aedeagus (Figs 5J-L) 0.59 mm; median lobe strongly asymmetric, bifid at apex; parameres short and apically broadened; endophallus composed of two sclerites.

Fig 5. Male diagnostic features of *Pselaphodes bilobatus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

Female. Each eye composed of about 30 facets; antennae simple. Measurements: BL 3.02-3.03 mm, HL 0.65-0.68 mm, HW 0.59-0.61 mm, PL 0.62-0.65 mm, PW 0.61-0.62 mm, EL 0.71-0.73 mm, EW 1.12-1.16 mm, AL 0.99-1.02 mm, AW 1.26-1.31 mm.

Distribution: Nepal, Koshi.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and can be readily separated from all congeners of the group based on the angulate pronotal lateral margins, the broad male protibiae, and the unique forms of the male antennal clubs and the aedeagus.

Etymology: The specific epithet refers to the bi-lobed apex of the aedeagal median lobe of the new species.

Fig 6. Male diagnostic features of *Pselaphodes corniger* sp. nov. (A) Antennal club. (B) Head, in lateral view. (C) Pronotum. (D) Metaventral process, in lateral view. (E) Protrochanter and profemur. (F) Apex of protibia. (G) Mesotrochanter and mesofemur. (H) Apex of mesotibia. (I) Metatrochanter and metafemur. (J) Sternite IX. (K-M) Aedeagus, in dorsal (K), lateral (L), and ventral (M) view. Scale bars: 0.3 mm in A-C, E, G, I; 0.2 mm in D, K-M; 0.1 mm in F, H, J.

Pselaphodes corniger sp. nov.

Figs 4B, 6A-M

Type material (1 specimen)**:** Holotype; MHNG-ENTO-43981; ♂; NEPAL, 'NEPAL (Prov. Bagmati), Pokhare NE Barahbise, 3000 m, 7.V.81, Löbl & Smetana' (MHNG).

Type locality: Nepal, Sindhupalchok District, Pokhare NE Barahbise, 3000 m alt.

Diagnosis of males: Length 3.32 mm. Clypeus projected anteriorly, forming horn-like process in male. Antennomeres 9 with large projection at apex, antennomeres 10 with distinct projection at base. Metaventral processes long, apically broadened. Protrochanters with small ventral spine, profemora with blunt ventral spine, protibiae with triangular preapical spine; mesotrochanters with distinct ventral spine, mesotibiae with small projection at apex. Median lobe of aedeagus abruptly narrowed apically; parameres slender at base and strongly broadened apically.

Description: Male (Fig. 4B). Body reddish brown, BL 3.32 mm. Head as long as wide, HL 0.62 mm, HW 0.62 mm, clypeus projected anteriorly, forming horn-like process (Fig. 6B); each eye composed of about 35 facets; with well-developed ocular canthus. Antennomeres (Fig. 6A) 9-11 forming distinct club, antennomeres 9 with large projection at apex, antennomeres 10 with distinct projection at base. Pronotum (Fig. 6C) longer than wide, PL 0.78 mm, PW 0.70 mm, angularly expanded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.84 mm, EW 1.23 mm. Metaventral processes (Fig. 6D) long, apically broadened. Protrochanters with small ventral spine, profemora with large, blunt ventral spine (Fig. 6E), protibiae (Fig. 6F) with triangular spine near apex; mesotrochanters (Fig. 6G) with distinct ventral spine; mesotibiae (Fig. 6H) with small projection at apex; metatrochanters and metafemora (Fig. 6I) simple. Abdomen broad at base and narrowing apically, AL 1.08 mm, AW 1.40 mm. Sternite IX semi-membranous, shape as in Fig. 6J. Length of aedeagus (Figs 6K-M) 0.76 mm; median lobe asymmetric, apically narrowed; parameres moderately elongate, basally narrowed and broadening apically; endophallus composed of one long and one short sclerite.

Female. Unknown.

Distribution: Nepal, Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and is most similar to *P. unicornis* Bekchiev & Hlaváč from Nepal and *P. monoceros* Yin & Hlaváč from Xizang based on the modified clypeus of the male. *Pselaphodes corniger* can be readily separated from both known species based on the presence of a preapical spine of the protibiae (spine at the apex of the protibiae in *P. unicornis* and *P. monoceros*), as well as the unique forms of the antennal clubs, metaventral processes, and the strongly asymmetric median lobe of the aedeagus (median lobe nearly symmetric dorso-ventrally in *P. unicornis* and *P. monoceros*).

Etymology: The specific epithet refers to the horned clypeus of the new species.

Pselaphodes coxatus sp. nov.

Figs 7A, 8A-L

Type material (10 specimens)**:** Holotype; MHNG-ENTO-43982; ♂; NEPAL, 'NEPAL (Prov. Bagmati), Yangri Ridge, 4500 m, 23.IV.81, Löbl & Smetana' (MHNG). – Paratypes; MHNG-ENTO-43983 to 43984; 2 ♂♂; NEPAL, same label data as holotype. – MHNG-ENTO-43985 to 43991; 2 ♂♂, 5 ♀♀; NEPAL, same label data as holotype, except '4350 m, 22.IV.81' (all paratypes in MHNG).

Type locality: Nepal, Sindhupalchowk District, Yangri Mountain, 4500 m alt.

Diagnosis of males: Length 3.10-3.19 mm. Antennomeres 9 with disc-shaped process at apex, antennomere 10 with distinct projection at base. Metaventral processes long, apically expanded. Protrochanters with slender ventral spine, profemora with small ventral spine, protibiae with blunt projection at apex; mesotrochanters with long acute ventral spine, mesotibiae with tiny projection at apex; metacoxae with short ventral projection. Median lobe of aedeagus broad and strongly asymmetric at apex; parameres moderately broadened throughout entire length.

Description: Male (Fig. 7A). Body reddish brown, BL 3.10-3.19 mm. Head longer than wide, HL 0.62-0.64 mm, HW 0.56-0.58 mm; each eye composed of about 26 facets; with well-developed ocular canthus. Antennomeres (Fig. 8A) 9-11 forming distinct club, antennomeres 9 with disc-shaped process at apex, antennomeres 10 with distinct projection at base. Pronotum (Fig. 8B) longer than wide, PL 0.67-0.68 mm, PW 0.64-0.65 mm, angularly expanded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.82-0.84 mm, EW 1.20-1.22 mm. Metaventral processes (Fig. 8C) long, apically broadened. Protrochanters with slender ventral spine, profemora with small ventral spine (Fig. 8D), protibiae (Fig. 8E) with blunt projection at apex; mesotrochanters (Fig. 8F) with long acute ventral spine, mesotibiae (Fig. 8G) with small projection at apex; metacoxae (Fig. 8H) with short ventral projection. Abdomen broad at base and narrowing apically, AL 0.99-1.03 mm, AW 1.29-1.32 mm. Sternite IX semi-membranous, shape as in Fig. 8I. Length of aedeagus (Figs 8J-L) 0.66 mm; median lobe broad and strongly asymmetric at apex; parameres moderately broadened throughout entire length; endophallus composed of two long sclerites.

Female. Each eye composed of about 28 facets; antennae simple. Measurements: BL 3.13-3.19 mm, HL 0.62-0.67 mm, HW 0.59-0.62 mm, PL 0.65-0.67 mm, PW 0.65-0.70 mm, EL 0.76-0.81 mm, EW 1.23-1.29 mm, AL 1.05-1.09 mm, AW 1.44-1.47 mm.

Distribution: Nepal, Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and can be readily separated from all congeners of the group based on the roundly angulate pronotal lateral margins, the strongly broadened male profemora, and the unique forms of the male antennal clubs and aedeagus.

Etymology: The specific epithet refers to the spinose male metacoxae of the new species.

***Pselaphodes khandbarius* sp. nov.**

Figs 7B, 9A-K

Type material (15 specimens)**:** Holotype; MHNG-ENTO-43992; ♂; NEPAL, 'NEPAL, Khandbari District, above Tashigaon, 3600 m, 6.IV.1982, A. & Z. Smetana' (MHNG). – Paratypes; MHNG-ENTO-43993 to 43998; 5 ♂♂, 1 ♀; NEPAL, same label data as holotype (MHNG). – 5 ♂♂, 2 ♀; CHINA, 'China: Xizang, Cuona County (错那县), 13 km of Bian-fang-liu-lian Road. (边防六连公路13公里处), 2016.VI.4, 3356 m, N° 27.8050, E° 91.7620, beating, Hong-Bin Liang (梁红斌) leg.' (IZ-CAS). – 1 ♂, also from Cuona, 'Le Village, Simuzha Park (勒村斯木扎景区), 2016.VI.1, 2793 m, N° 27.8262, E° 91.7293, Hong-Bin Liang leg.' (IZ-CAS)'.

Fig 7. Dorsal habitus of *Pselaphodes* males. (A) *P. coxatus* sp. nov. (B) *P. khandbarius* sp. nov. Scale bars: 1 mm.

Type locality: Nepal, Khandbari District, above Tashigaon, 3600 m alt.

Diagnosis of male: Length 2.71-2.76 mm. Antennomeres 9 strongly constricted at apical third, with disc-shaped process at apex, antennomeres 10 with strongly constricted at base, asymmetrically conjoined to antennomeres 9. Metaventral processes long, with pair of small projection in addition to long processes. Profemora with large ventral spine, protibiae with acute spine at apex; mesotrochanters with three ventral spines. Median lobe of aedeagus nearly asymmetric, strongly constricted at apex; parameres long and symmetric.

Description: Male (Fig. 7B). Body reddish brown, BL 2.71-2.76 mm. Head longer than wide, HL 0.57-

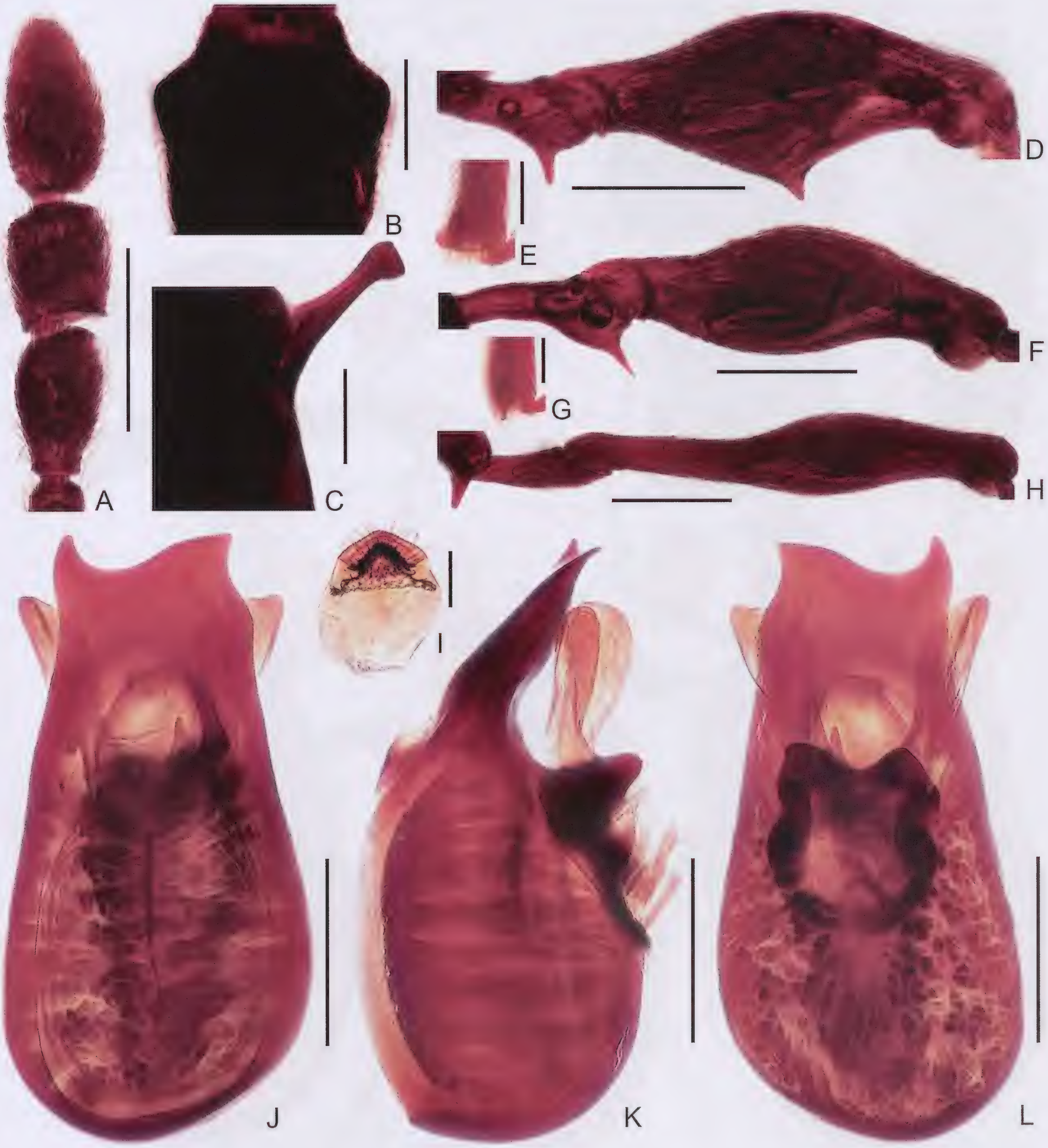

Fig 8. Male diagnostic features of *Pselaphodes coxatus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

0.59 mm, HW 0.55-0.57 mm; each eye composed of about 38 facets; with well-developed ocular canthus. Antennomeres (Fig. 9A) 9-11 forming distinct club, antennomeres 9 strongly constricted at apex, and with disc-shaped apical process, antennomeres 10 strongly constricted at base, laterally conjoined to antennomeres 9. Pronotum (Fig. 9B) wider than long, PL 0.54-0.55 mm, PW 0.55-0.57 mm, rounded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.84-0.88 mm, EW 1.12-1.17 mm. Metaventral processes (Fig. 9C) long, with pair of small projection in addition to long processes. Protrochanters with small spine, profemora with distinct large ventral spine (Fig. 9D), protibiae (Fig. 9E) with acute spine at apex; mesotrochanters (Fig. 9F) with three ventral spines, metatrochanters and metafemora (Fig. 9G)

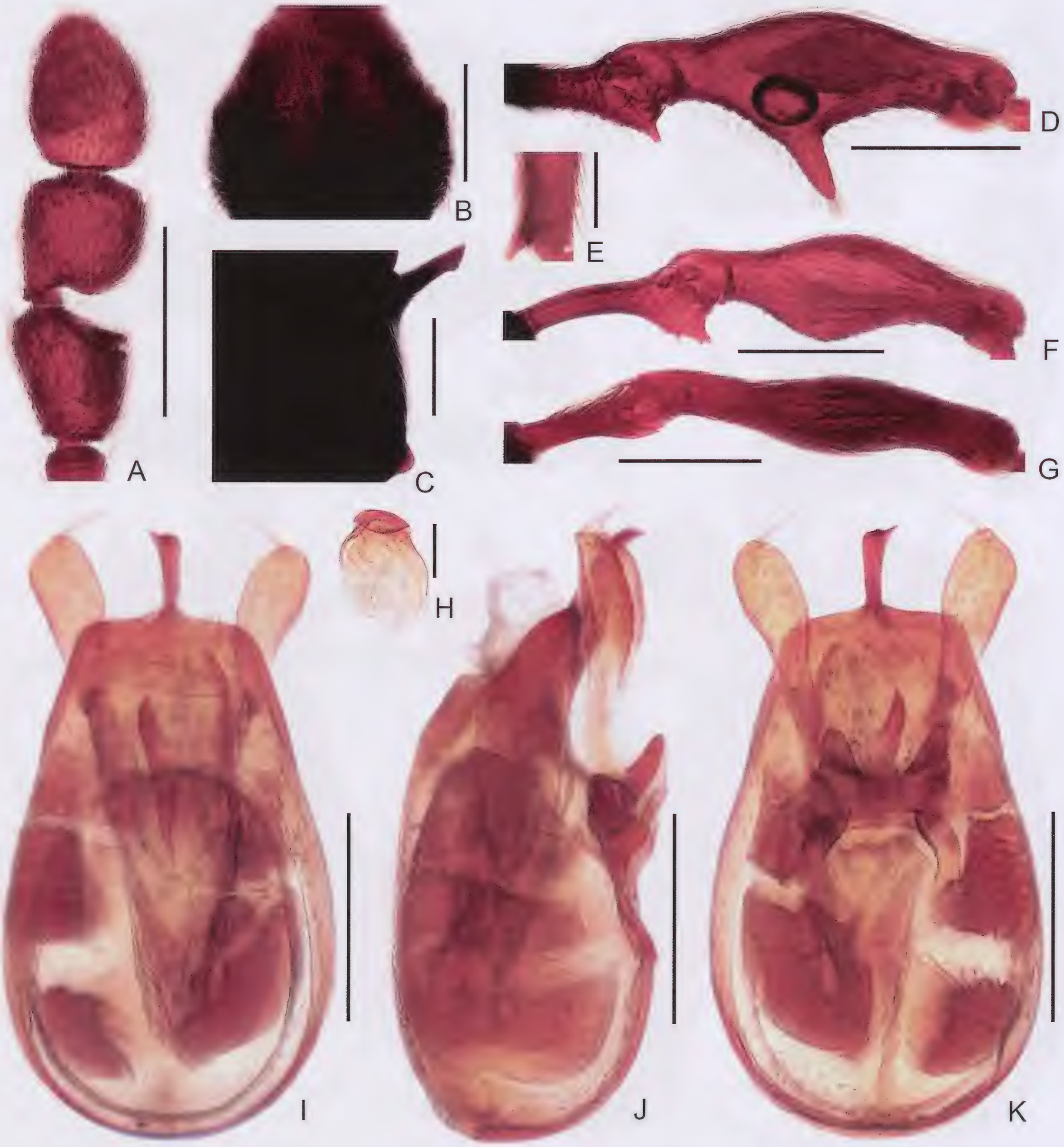

Fig 9. Male diagnostic features of *Pselaphodes khandbarius* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Metatrochanter and metafemur. (H) Sternite IX. (I-K) Aedeagus, in dorsal (I), lateral (J), and ventral (K) view. Scale bars: 0.3 mm in A-B, D, F-G; 0.2 mm in C, I-K; 0.1 mm in E, H.

simple. Abdomen broad at base and narrowing apically, AL 0.74-0.76 mm, AW 1.16-1.17 mm. Sternite IX semi-membranous, shape as in Fig. 9H. Length of aedeagus (Figs 9I-K) 0.63 mm; median lobe asymmetric, strongly narrowed at apex; parameres long, almost symmetric, each with one macroseta at apex; endophallus composed of one long and one short sclerites.

Female. Each eye composed of about 32 facets; antennae simple. Measurements: BL 2.50 mm, HL 0.53 mm, HW 0.52 mm, PL 0.54 mm, PW 0.53 mm, EL 0.64 mm, EW 1.02 mm, AL 0.79 mm, AW 1.16 mm.

Distribution: Nepal, Koshi; China, Xizang.

Comparative notes: The new species seems to be a derived member of the *P. bagmatius* species-group, and can be readily recognized based on the unique form of the male antennal clubs, the distinct large ventral spine of the profemora, the multiple spines of the mesotrochanters, the almost symmetric median lobe of the aedeagus, and the elongate parameres with single long apical seta. The males of Xizang, China differs slightly from that of Nepal in the form of the apex of the aedeagal median lobe (shallowly split), but otherwise the combination of the rest sexual features seems quite stable.

Etymology: The specific epithet refers to the type locality of the new species, *i.e.*, Khandbari District.

***Pselaphodes loebli* sp. nov.**

Figs 10A, 11A-L

Type material (9 specimens): Holotype; MHNG-ENTO-43999; ♂; NEPAL, 'NEPAL (Prov. Bagmati),

Fig 10. Dorsal habitus of *Pselaphodes* males. (A) *P. loebli* sp. nov. (B) *P. procerus* sp. nov. Scale bars: 1 mm.

Malemchi, 2800 m, 14.IV.81, Löbl & Smetana'. – Paratypes; MHNG-ENTO-44000 to 44007; 3 ♂♂, 5 ♀♀; NEPAL, same label data as holotype (MHNG).

Type locality: Nepal, Sindhupalchok District, Melamchi, 2900 m alt.

Diagnosis of males: Length 3.01-3.14 mm. Antennomeres IX with disc-shaped process at apex. Metaventral processes long, with pair of small projection in addition to long processes. Protrochanters with slender ventral spine, profemora with large, blunt ventral spine, protibiae with acute spine at apex; mesotrochanters with multiple ventral spines, mesotibiae with small tubercle at apex. Median lobe of aedeagus almost symmetric, narrowing apically; parameres broad dorso-ventrally.

Description: Male (Fig. 10A). Body reddish brown, BL 3.01-3.14 mm. Head about as long as wide, HL 0.58-0.62 mm, HW 0.59-0.61 mm; each eye composed of about 40 facets; with well-developed ocular canthus. Antennomeres (Fig. 11A) 9-11 forming distinct club, antennomeres 9 with disc-shaped process at apex, antennomeres 10 constricted mediobasally. Pronotum (Fig. 11B) longer than wide, PL 0.64-0.70 mm, PW 0.64-0.65 mm, rounded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.81-0.84 mm, EW 1.28-1.34 mm. Metaventral processes (Fig. 11C) long, with pair of small projection in addition to long processes. Protrochanters with slender ventral spine, profemora with large, blunt ventral spine (Fig. 11D), protibiae (Fig. 11E) with acute spine at apex; mesotrochanters with multiple small to large spines (Fig. 11F); mesotibiae (Fig. 11G) with small projection at apex; metatrochanters and metafemora (Fig. 11H) simple. Abdomen broad at base and narrowing apically, AL 0.94-1.02 mm, AW 1.31-1.35 mm. Sternite IX semi-membranous, shape as in Fig. 11I. Length of aedeagus (Figs 11J-L) 0.62 mm; median lobe almost symmetric; parameres elongate and broad dorso-ventrally; endophallus composed of one long and one short sclerites.
Female. Each eye composed of about 33 facets; antennae simple. Measurements: BL 2.97-2.98 mm, HL 0.59-0.61 mm, HW 0.58-0.61 mm, PL 0.64-0.68 mm, PW 0.64-0.68 mm, EL 0.68-0.70 mm, EW 1.23-1.26 mm, AL 1.02-1.03 mm, AW 1.38-1.44 mm.

Distribution: Nepal, Bagmati.

Comparative notes: The new species is a member of the *P. bagmatius* species-group, and can be readily recognized based on the unique forms of the male antennal clubs, the distinct large ventral spine of the profemora, and the almost symmetric aedeagus with broadened parameres.

Etymology: The new species is named after Ivan Löbl, co-collector of the holotype.

***Pselaphodes procerus* sp. nov.**
Figs 10B, 12A-L

Type material (1 specimen)**:** Holotype; MHNG-ENTO-44008; ♂; NEPAL, 'C-Nepal: Manaslu massif, Barapokhari Lekh, 23 km, NE Besisahar vill. 28°21′N, 84°33′E, 14.IX.2000, leg. A. Hetzel, 3800-4100 m, sieved from moss and *Rhododendron* leaf litter' (MHNG).

Type locality: Nepal, Lamjung District, Manaslu Mountain, Bara Pokhari, 3800-4100 m alt.

Diagnosis of males: Length 3.15 mm. Antennomere 9 with projection at apex, antennomeres 10 with distinct projection at base. Metaventral processes broad, and apically forked. Protrochanters with acute ventral spine, profemora with blunt ventral spine, protibiae with distinct projection at apex; mesotrochanters with long acute ventral spine, mesotibiae with two distinct projections at apex; metacoxae with large blunt ventral projection. Median lobe of aedeagus broad apically; parameres moderately elongate and apically broadened.

Description: Male (Fig. 10B). Body reddish brown, BL 3.15 mm. Head longer than wide, HL 0.67 mm, HW 0.62 mm; each eye composed of about 45 facets; with well-developed ocular canthus. Antennomeres (Fig. 12A) 9-11 forming distinct club, antennomeres 9 with projection at apex, antennomeres 10 with distinct projection at base. Pronotum (Fig. 12B) as long as wide, PL 0.65 mm, PW 0.65 mm, angularly expanded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.96 mm, EW 1.34 mm. Metaventral processes (Fig. 12C) broad, apically forked, anterior branch smaller than posterior branch. Protrochanters with acute ventral spine, profemora with large, blunt ventral spine (Fig. 12D), protibiae (Fig. 12E) with distinct projection at apex; mesotrochanters (Fig. 12F) with long, sharp ventral spine; mesotibiae (Fig. 12G) with two distinct projections at apex; metacoxae (Fig. 12H) with large blunt ventral projection. Abdomen broad at base and narrowing apically, AL 0.87 mm, AW 1.31 mm. Sternite IX semi-membranous, shape as in Fig. 12I. Length of aedeagus (Figs 12J-L) 0.69 mm; median lobe broad and asymmetric (basal capsule collapsed in holotype); parameres narrowed at base and broadened apically; endophallus composed of one long and one short sclerites.
Female. Unknown.

Distribution: Nepal, Gandaki.

Comparative notes: The new species is a member of the *P. bagmatius* species-group, and can be readily recognized based on the unique forms of the male antennal clubs, the distinct large ventral projection of the metacoxae, and the broad apex of the median lobe of the aedeagus.

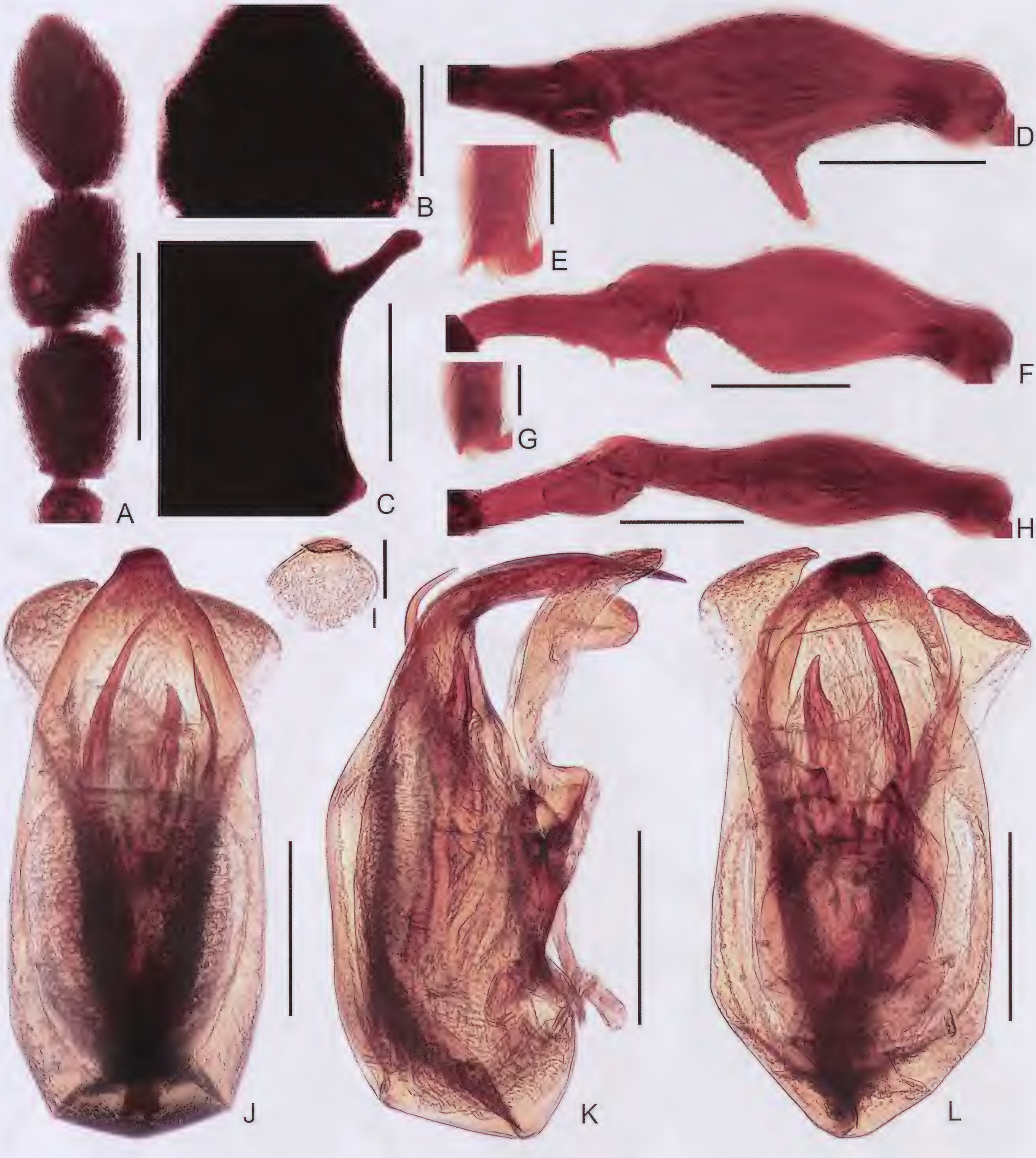

Fig 11. Male diagnostic features of *Pselaphodes loebli* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

Fig 12. Male diagnostic features of *Pselaphodes procerus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

Etymology: The specific epithet refers to the large blunt projection of the metacoxa of the new species.

Pselaphodes psomus sp. nov.

Figs 13A, 14A-L

Type material (23 specimens)**:** Holotype; MHNG-ENTO-44009; ♂; NEPAL, 'NEPAL (Prov. Bagmati), Gul Bhanjyang, 2600 m, 6.IV.81, Löbl & Smetana' (MHNG). – Paratypes; MHNG-ENTO-44010; 1 ♀; NEPAL, same label data as holotype. – MHNG-ENTO-44011; 1 ♂; NEPAL, same label data as holotype, except 'Chaubas, 5.IV.81'. – MHNG-ENTO-44012 to 44013; 1 ♂, 1 ♀; NEPAL, same label data as holotype, except 'Phulchauki nr. Kathmandu, 2500 m, 10.V.81, l. Löbl'. – MHNG-ENTO-44014 to 44015; 2 ♂♂, 1 ♀; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2700 m, 16.X.83, Smetana & Löbl'. – MHNG-ENTO-44016 & 44017; 1 ♂, 1 ♀; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2700 m, 15.X.83, Smetana & Löbl'. – MHNG-ENTO-44018 to 44021; 2 ♂♂, 2 ♀♀; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2550 m, 15.X.83, Smetana & Löbl'. – MHNG-ENTO-44022; 1 ♂; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2650 m, 13.X.83, Smetana & Löbl'. – MHNG-ENTO-44023 to 44027; 1 ♂, 4 ♀♀; NEPAL, 'NEPAL, Kathmandu District, Phulcoki, 2600 m, 20.IV.1982, A. & Z. Smetana'. – MHNG-ENTO-44028; 1 ♂; NEPAL, 'NEPAL, Kathmandu District, Phulcoki, 2650 m, 21.IV.1982, A. & Z. Smetana'. – MHNG-ENTO-44029; 1 ♂; NEPAL, 'NEPAL, Phulchoki, 3.II.1982, de Rougemont'. – MHNG-ENTO-44030; 1 ♂; NEPAL 'Nepal, Pulchoki/godabari, 2750 m, Deharveng' (all paratypes in MHNG).

Type locality: Nepal, Sindhupalchok District, Helambu Valley, Gul Bhanjyang, 2600 m alt.

Fig 13. Dorsal habitus of *Pselaphodes* males. (A) *P. psomus* sp. nov. (B) *P. robustus* sp. nov. Scale bars: 1 mm.

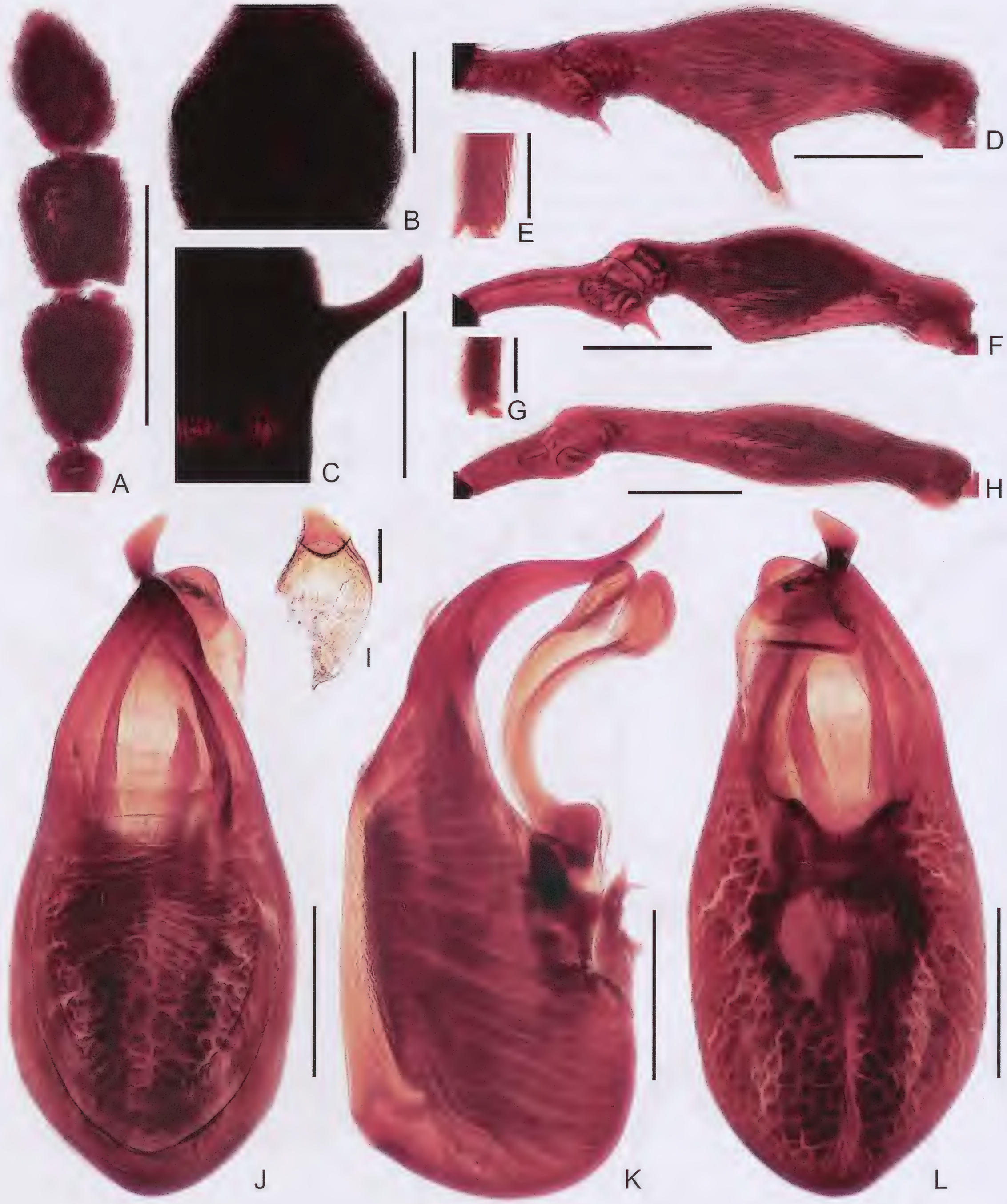

Fig 14. Male diagnostic features of *Pselaphodes psomus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

Diagnosis of males: Length 2.95-3.06 mm. Antennomeres 9 with disc-shaped process at apex. Metaventral processes long. Protrochanters with slender ventral spine, profemora with large blunt ventral spine, protibiae with distinct spine at apex; mesotrochanters with two ventral spines, mesotibiae with small tubercle at apex. Median lobe of aedeagus extending at apex; parameres elongate and broadened at apex.

Description: Male (Fig. 13A). Body reddish brown, BL 2.95-3.06 mm. Head as long as wide, HL 0.58-0.62 mm, HW 0.58-0.62 mm; each eye composed of about 35 facets; with well-developed ocular canthus. Antennomeres (Fig. 14A) 9-11 forming distinct club, antennomeres 9 with disc-shaped process at apex, antennomeres 10 projected posteriorly at base. Pronotum (Fig. 14B) almost as long as wide, PL 0.65-0.67 mm, PW 0.64-0.65 mm, rounded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.74-0.81 mm, EW 1.26-1.29 mm. Metaventral processes (Fig. 14C) long. Protrochanters with slender ventral spine, profemora with large blunt ventral spine (Fig. 14D), protibiae (Fig. 14E) with distinct spine at apex; mesotrochanters (Fig. 14F) with two ventral spines; mesotibiae (Fig. 14G) with small projection at apex; metatrochanters and metafemora (Fig. 14H) simple. Abdomen broad at base and narrowing apically, AL 0.94-1.00 mm, AW 1.38-1.41 mm. Sternite IX semi-membranous, shape as in Fig. 14I. Length of aedeagus (Figs 14J-L) 0.86 mm; median lobe slightly asymmetric, strongly extended and constricted apically; parameres rather elongate and apically broadened; endophallus composed of one long and one short sclerites.

Female. Each eye composed of about 23 facets; antennae simple. Measurements: BL 2.99-3.02 mm, HL 0.56-0.58 mm, HW 0.56-0.58 mm, PL 0.65-0.70 mm, PW 0.64-0.67 mm, EL 0.67-0.71 mm, EW 1.25-1.28 mm, AL 1.05-1.09 mm, AW 1.41-1.44 mm.

Distribution: Nepal, Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and is most similar to *P. smetanai* described below in sharing similar forms of the antennal clubs, and the median lobe of the aedeagus being strongly extending apically. *Pselaphodes psomus* can be separated from *P. smetanai* only based on the slightly different position of the apical process of the antennomeres 9, the relatively longer metaventral processes with a different form of the apex, and the longer ventral spine of the profemora.

Etymology: The specific epithet refers to the round apical process of male antennomeres 9 of the new species.

Pselaphodes robustus sp. nov.

Figs 13B, 15A-K

Type material (32 specimens)**:** Holotype; MHNG-ENTO-44031; ♂; NEPAL, 'NEPAL: distr. Kathmandu: Phulcoki, 2400-2600 m, 28-30.IV.84, Löbl - Smetana' (MHNG). – Paratypes; MHNG-ENTO-44032 to 44036; 2 ♂♂, 3 ♀♀; NEPAL, same label data as holotype. – MHNG-ENTO-44037 to 44047; 5 ♂♂, 6 ♀♀; NEPAL, same label data as holotype, except '2500 m, 28-29. IV.84'. – MHNG-ENTO-44048 & 44049; 1 ♂, 1 ♀; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2600 m, 14.X.83, Smetana & Löbl'. – MHNG-ENTO-44050 to 44054; 3 ♂♂, 2 ♀♀; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2650 m, 13.X.83, Smetana & Löbl'. – MHNG-ENTO-44055 to 44056; 2 ♂♂; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2550 m, 15.X.83, Smetana & Löbl'. – MHNG-ENTO-44057; 1 ♂; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2700 m, 16.X.83, Smetana & Löbl'. – MHNG-ENTO-44058; 1 ♂; NEPAL, 'NEPAL (Prov. Bagmati), Phulchauki nr., Kathmandu, 2500 m, 10.V.81, l. Löbl'. – MHNG-ENTO-44059 to 44062; 2 ♂♂, 2 ♀♀; NEPAL, 'NEPAL, Kathmandu District, Phulcoki, 2550 m, 21.IV.1982, A. & Z. Smetana' (all paratypes in MHNG).

Type locality: Nepal, Kathmandu District, Phulchoki Hill, 2400-2600 m alt.

Diagnosis of males: Length 3.37-3.43 mm. Antennomeres 9 with disc-shaped process at apex. Metaventral processes short and broad. Protrochanters with small ventral spine, profemora with bluntly triangular projection, protibiae with small projection at apex; mesotrochanter with sharp ventral spine. Median lobe of aedeagus strongly asymmetric at apex; parameres elongate and broadened throughout entire length.

Description: Male (Fig. 13B). Body reddish brown, BL 3.37-3.43 mm. Head longer than wide, HL 0.71-0.74 mm, HW 0.63-0.65 mm; each eye composed of about 32 facets; with well-developed ocular canthus. Antennomeres 9-11 (Fig. 15A) forming distinct club, antennomeres 9 slightly modified, with disc-shaped process at apex, antennomeres 10 simple. Pronotum (Fig. 15B) longer than wide, PL 0.71-0.76 mm, PW 0.66-0.68 mm, angularly expanded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.88-0.89 mm, EW 1.34-1.41 mm. Metaventral processes (Fig. 15C) short and broad, apically rounded. Protrochanters with small ventral spine, profemora with bluntly triangular ventral projection (Fig. 15D), protibiae (Fig. 15E) with small projection at apex; mesotrochanters (Fig. 15F) with sharp triangular ventral spine; metatrochanters and metafemora (Fig. 15G) simple. Abdomen broad at base and narrowing apically, AL 1.03-1.06 mm, AW 1.46-1.49 mm. Sternite IX semi-membranous, shape as in Fig. 15H. Length of aedeagus (Figs 15I-K)

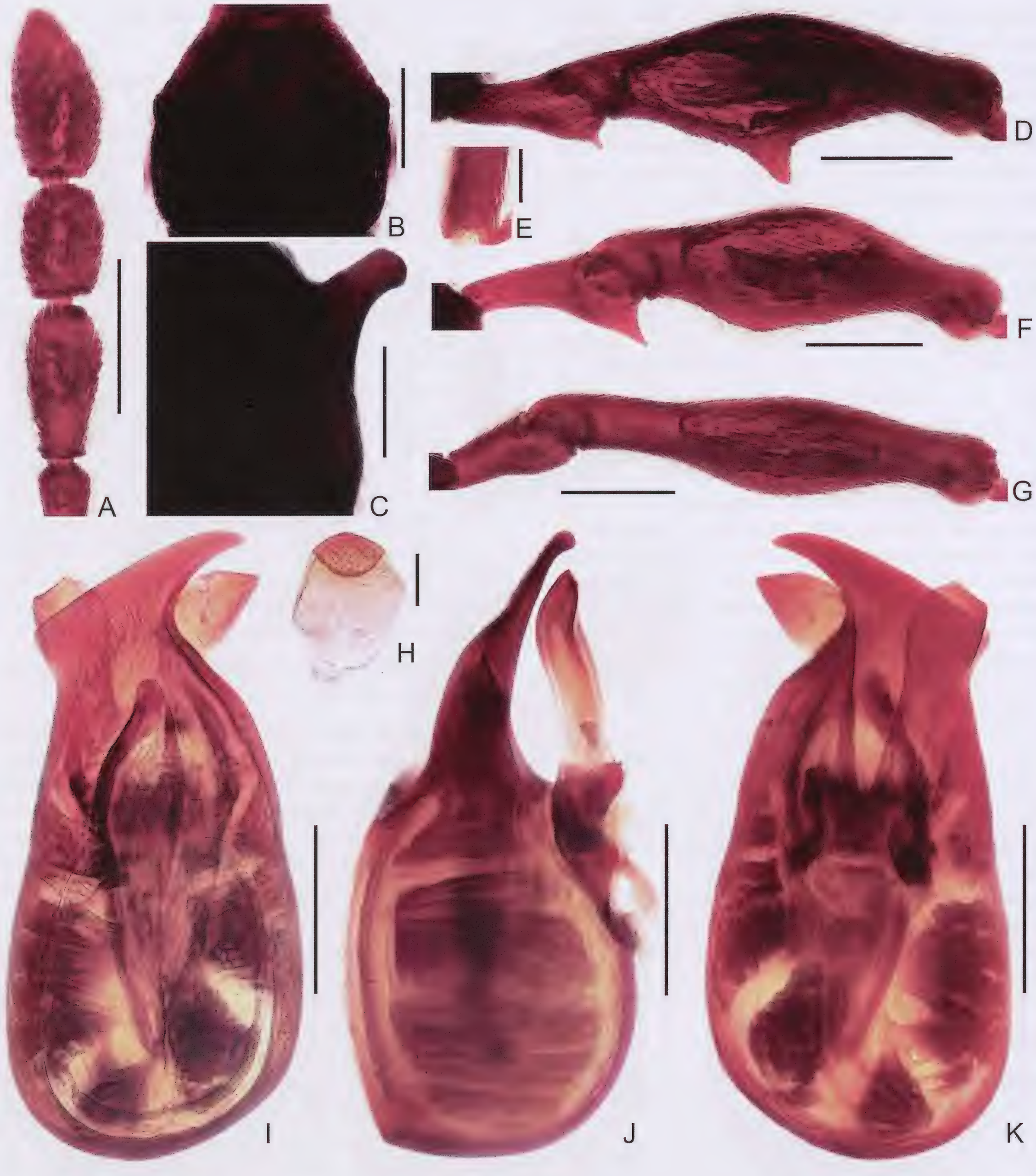

Fig 15. Male diagnostic features of *Pselaphodes robustus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Metatrochanter and metafemur. (H) Sternite IX. (I-K) Aedeagus, in dorsal (I), lateral (J), and ventral (K) view. Scale bars: 0.3 mm in A-B, D, F-G; 0.2 mm in C, I-K; 0.1 mm in E, H.

0.75 mm; median lobe broad and strongly asymmetric; parameres moderately broadened throughout entire length; endophallus composed of one long and one short sclerites.

Female. Each eye composed of about 30 facets; antennae simple. Measurements: BL 3.21-3.64 mm, HL 0.63-0.74 mm, HW 0.62-0.68 mm, PL 0.69-0.73 mm, PW 0.67-0.69 mm, EL 0.82-0.88 mm, EW 1.20-1.46 mm, AL 1.00-1.29 mm, AW 1.44-1.57 mm.

Distribution: Nepal, Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, but has less modified antennal clubs. It can be readily separated from all other members of the group based on the elongate antennomeres, the short metaventral processes, and the apically strongly asymmetric median of the aedeagus.

Etymology: The specific epithet refers to the short and broad male metaventral processes of the new species.

Pselaphodes rotundatus sp. nov.

Figs 16A, 17A-L

Type material (5 specimens)**:** Holotype; MHNG-ENTO-44063; ♂; NEPAL, 'NEPAL (Prov. Bagmati), below Thare Pati, 3300 m, 11.IV.81, Löbl & Smetana'. – Paratypes; MHNG-ENTO-44064 to 44066; 1 ♂, 2 ♀♀; NEPAL, same label data as holotype. – MHNG-ENTO-44067; paratype, 1 ♂; NEPAL, same label data as holotype, except '10.IV.81' (all paratypes in MHNG).

Type locality: Nepal, Sindhupalchok District, Melamchi, Thare Pati, 3300 m alt.

Fig 16. Dorsal habitus of *Pselaphodes* males. (A) *P. rotundatus* sp. nov. (B) *P. sagephorus sp.* nov. Scale bars: 1 mm.

Diagnosis of males: Length 3.10-3.13 mm. Antennomeres 9 with large disc-shaped process at apex, antennomeres 10 with small projection at base. Metaventral processes broad, forked at apex. Profemora with triangular ventral spine, protibiae with distinct spine at apex; mesotrochanters with slender ventral spine, mesotibiae with small projection at apex; metacoxae with short ventral projection. Median lobe of aedeagus broad and asymmetric at apex; parameres short.

Description: Male (Fig. 16A). Body reddish brown, BL 3.10-3.13 mm. Head longer than wide, HL 0.61-0.62 mm, HW 0.53-0.56 mm; each eye composed of about 43 facets. Antennomeres (Fig. 17A) 9-11 forming distinct club, antennomeres 9 with large disc-shaped process at apex, antennomeres 10 with small projection

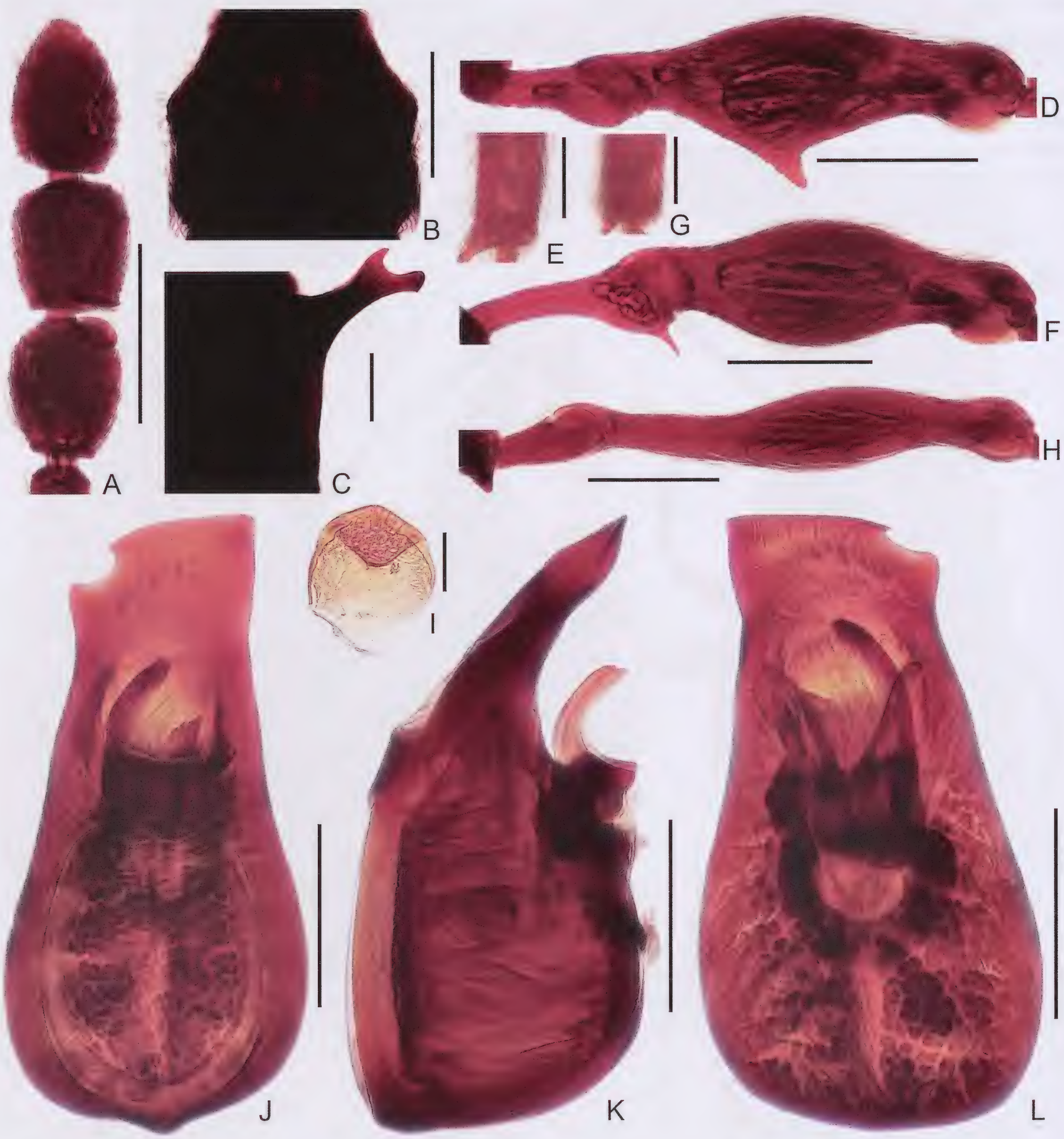

Fig 17. Male diagnostic features of *Pselaphodes rotundatus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

at base. Pronotum (Fig. 17B) slightly longer than wide, PL 0.61-0.62 mm, PW 0.58-0.59 mm, angularly expanded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.88-0.94 mm, EW 1.12-1.19 mm. Metaventral processes (Fig. 17C) broad, apically forked, anterior branch shorter than posterior branch. Profemora (Fig. 17D) with triangular ventral spine, protibiae (Fig. 17E) with distinct spine at apex; mesotrochanters (Fig. 17F) with acute ventral spine; mesotibiae (Fig. 17G) with small tubercle at apex; metacoxa (Fig. 17H) with short ventral projection. Abdomen broad at base and narrowing apically, AL 0.96-0.99 mm, AW 1.12-1.14 mm. Sternite IX semi-membranous, shape as in Fig. 17I. Length of aedeagus (Figs 17J-L) 0.65 mm; median lobe broad and asymmetric; parameres short, almost symmetric; endophallus composed of one long and one short sclerites.

Female. Each eye composed of about 35 facets; antennae simple. Measurements: BL 3.06-3.12 mm, HL 0.65-0.67 mm, HW 0.56-0.59 mm, PL 0.61-0.62 mm, PW 0.58-0.61 mm, EL 0.79-0.81 mm, EW 1.20-1.25 mm, AL 0.97-1.06 mm, AW 1.29-1.32 mm.

Distribution: Nepal: Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and can be readily separated from all other members of the group based on the relatively long elytra and forked metaventral processes of the male, as well as the unique form of the aedeagus.

Etymology: The specific epithet refers to the large disc-shaped process of the male antennomeres 9 of the new species.

Pselaphodes sagephorus sp. nov.

Figs 16B, 18A-K

Type material (10 specimens)**:** Holotype; MHNG-ENTO-44068; ♂; NEPAL, 'NEPAL: distr. Kathmandu: Phulcoki, 2500 m, 28-29.IV.84, Löbl - Smetana' (MHNG). – Paratypes; MHNG-ENTO-44069 & 44070; 1 ♂, 1 ♀; NEAPL, same label data as holotype. – MHNG-ENTO-44071 to 44072; 1 ♂, 1 ♀; NEAPAL, 'NEPAL (Prov. Bagmati), Pokhare NE Barahbise, 2700 m, 7.V.81, Löbl & Smetana'. – MHNG-ENTO-44073; 1 ♂; NEPAL, 'NEPAL (Prov. Bagmati), Malemchi, 2800 m, 14.IV.81, Löbl & Smetana'. – MHNG-ENTO-44074; 1 ♂; NEPAL, 'NEPAL (Prov. Bagmati), Gul Bhanjyang, 2600 m, 6.IV.81, Löbl & Smetana'. – MHNG-ENTO-44075; 1 ♂; NEPAL, 'NEPAL: Bagmati, Pokhare NE Barahbise, 2800 m, 3.5.81, Löbl - Smetana'. – MHNG-ENTO-44076; 1 ♂; NEPAL, 'NEPAL (Prov. Bagmati), Phulchauki nr. Kathmandu, 2500 m, 10.V.81, l. Löbl'. – MHNG-ENTO-44077; 1 ♂; NEPAL, 'NEPAL, Lalitpur Distr., Phulcoki, 2550 m, 15.X.83, Smetana & Löbl' (all paratypes in MHNG).

Type locality: Nepal, Kathmandu District, Phulchoki Hill, 2500 m alt.

Diagnosis of males: Length 3.41-3.42 mm. Antennomeres 9 with distinct projection and cavity at apex and mesal margin, with tuft of gold-colored setae inside cavity, antennomeres 10 with large projection at base. Metaventral processes long, apically narrowed, with pair of small projection in addition to long processes. Protrochanters with small ventral spine, profemora with large ventral spine, protibiae with blunt projection at apex; mesotrochanters with slender ventral spine; metafemora with large ventral spine. Median lobe of aedeagus slightly asymmetric at apex; parameres broad.

Description: Male (Fig. 16B). Body reddish brown, BL 3.41-3.42 mm. Head slightly longer than wide, HL 0.64-0.68 mm, HW 0.64-0.67 mm; each eye composed of about 45 facets; with well-developed ocular canthus. Antennomeres (Fig. 18A) 9-11 forming distinct club, antennomeres 9 with distinct projection and cavity at apex and mesal margin, with tuft of gold-colored setae inside cavity, antennomeres 10 with large, sharp projection at base. Pronotum (Fig. 18B) longer than wide, PL 0.72-0.74 mm, PW 0.68-0.69 mm, angularly expanded at anterolateral margins. Elytra wider than long, EL 0.84-0.95 mm, EW 1.32-1.41 mm. Metaventral processes (Fig. 18C) long and broad, narrowed at apex, with pair of small projection in addition to long processes. Protrochanters (Fig. 18D) with tiny spine, profemora with large ventral spine, protibiae (Fig. 18E) with blunt projection at apex; mesotrochanters (Fig. 18F) with long, slender ventral spine; metatrochanters simple, metafemora (Fig. 18G) with large, sharp ventral spine. Abdomen broad at base and narrowing apically, AL 1.06-1.20 mm, AW 1.40-1.43 mm. Sternite IX semi-membranous, shape as in Fig. 18H. Length of aedeagus (Figs 18I-K) 0.59 mm; median lobe slightly asymmetric, narrowed at apex; parameres broad dorso-ventrally; endophallus composed of one long and one short sclerites.

Female. Each eye composed of about 35 facets; antennae simple. Measurements: BL 3.34 mm, HL 0.72 mm, HW 0.63 mm, PL 0.71 mm, PW 0.67 mm, EL 0.72 mm, EW 1.29 mm, AL 1.19 mm, AW 1.49 mm.

Distribution: Nepal, Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and can be readily separated from all other members of the group based on the expanded postgenae, strongly modified antennal clubs, long and broad metaventral processes, the long metafemoral spine of the male, and the unique configuration of the aedeagus.

Etymology: The specific epithet '*Sagephorus*' means

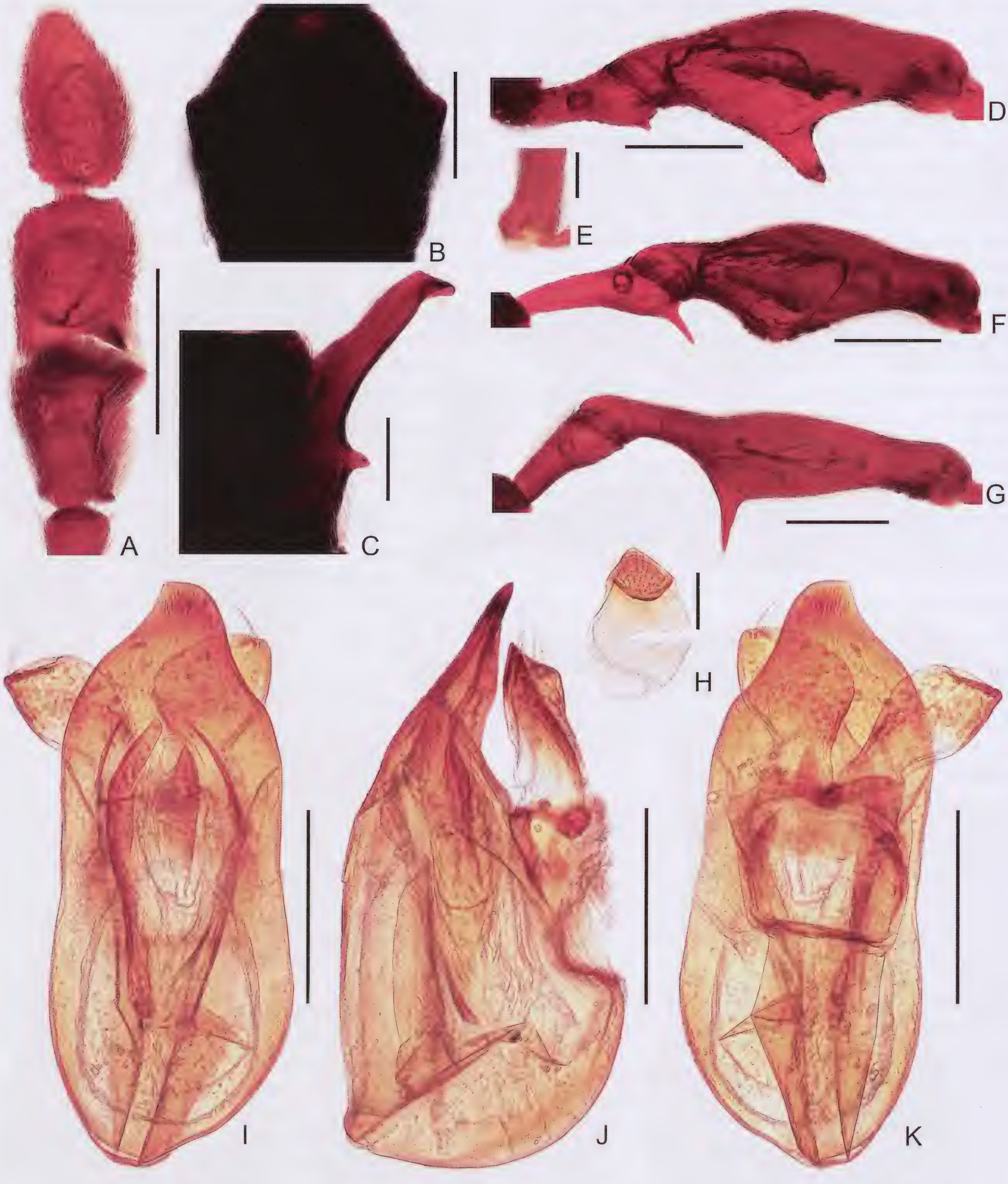

Fig 18. Male diagnostic features of *Pselaphodes sagephorus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Metatrochanter and metafemur. (H) Sternite IX. (I-K) Aedeagus, in dorsal (I), lateral (J), and ventral (K) view. Scale bars: 0.3 mm in A-B, D, F-G; 0.2 mm in C, I-K; 0.1 mm in E, H.

'well-armed', referring to the strongly modified head, antennae, and legs in the male of the new species.

***Pselaphodes smetanai* sp. nov.**
Figs 19A, 20A-K

Type material (1 specimen)**:** Holotype; MHNG-ENTO-44078; ♂; NEPAL, 'NEPAL: Bagmati, Pokhare NE Barahbise, 2800 m, 3.5.81, Löbl - Smetana' (MHNG).

Type locality: Nepal, Sindhupalchok District, Pokhare NE Barahbise, 2800 m alt.

Diagnosis of males: Length 2.90 mm. Antennomeres 9 with round projection at apex, antennomeres 10 with small projection at base. Metaventral processes long, with pair of small triangular projection in addition to long processes. Protrochanters with acute ventral spine, profemora with blunt ventral spine, protibiae with distinct spine at apex; mesotrochanters with two ventral spines, mesotibiae with small projection at apex. Median lobe of aedeagus slightly asymmetric and extending at apex; parameres elongate, narrowed at base and broadened at apex.

Description: Male (Fig. 19A). Body reddish brown, BL 2.90 mm. Head slightly longer than wide, HL 0.62 mm, HW 0.61 mm; each eye composed of about 35 facets; with well-developed ocular canthus. Antennomeres (Fig. 20A) 9-11 forming distinct club, antennomeres 9 with round projection at apex, antennomeres 10 with small tubercle at base. Pronotum (Fig. 20B) longer than wide, PL 0.73 mm, PW 0.67 mm, rounded

Fig 19. Dorsal habitus of *Pselaphodes* males. (A) *P. smetanai* sp. nov. (B) *P. symmetricus* sp. nov. Scale bars: 1 mm.

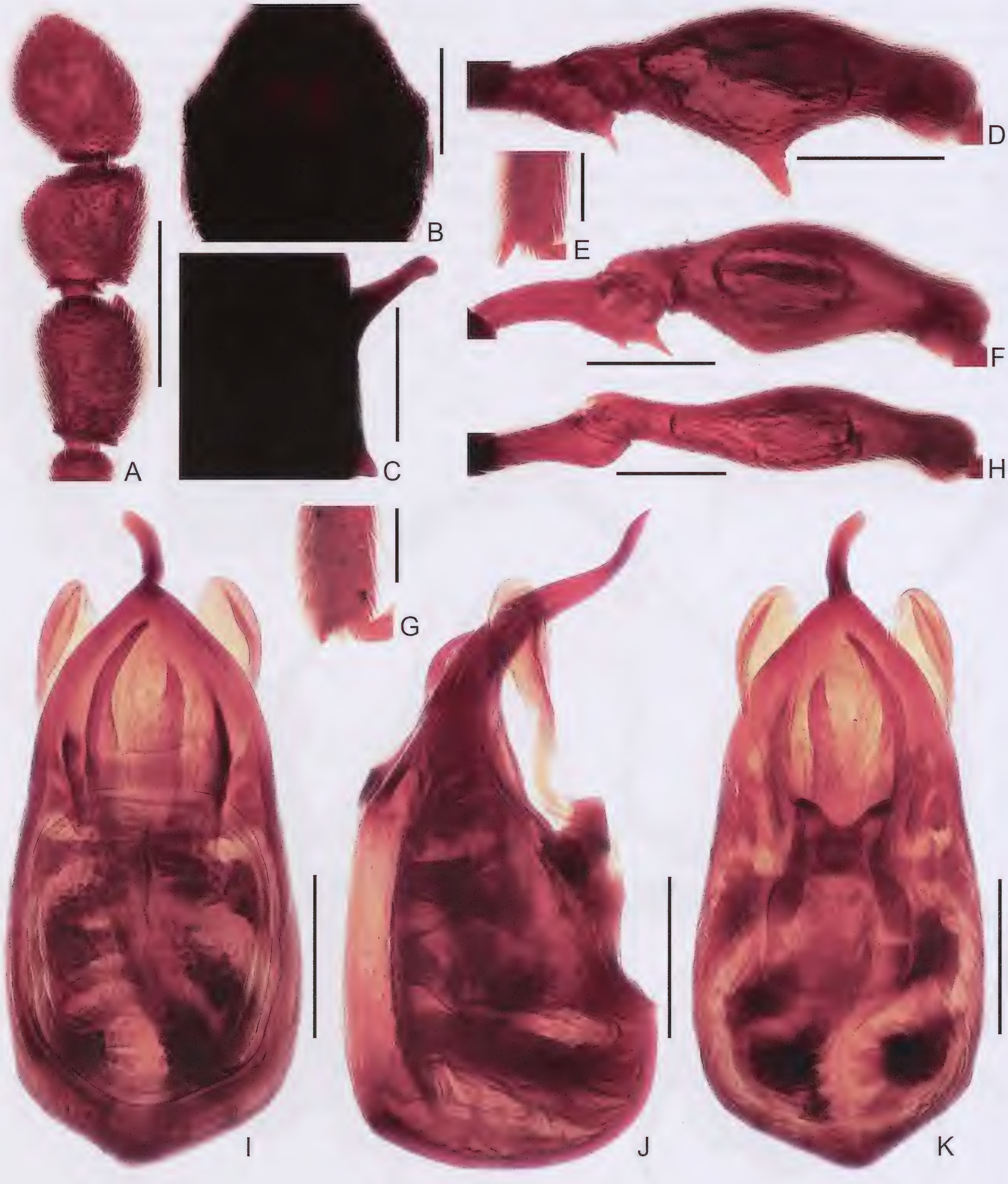

Fig 20. Male diagnostic features of *Pselaphodes smetanai* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I-K) Aedeagus, in dorsal (I), lateral (J), and ventral (K) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, I-K; 0.1 mm in E, G.

at anterolateral margins, constricted at apical third. Elytra wider than long, EL 0.61 mm, EW 1.25 mm. Metaventral processes (Fig. 20C) long, with pair of small triangular projection in addition to long processes. Protrochanters with acute ventral spine, profemora with large, blunt ventral spine (Fig. 20D), protibiae (Fig. 20E) with distinct spine at apex; mesotrochanters with two ventral spines (Fig. 20F), mesotibiae with small projection at apex (Fig. 20G); metatrochanters and metafemora (Fig. 20H) simple. Abdomen broad at base and narrowing apically, AL 0.94 mm, AW 1.32 mm. Length of aedeagus (Figs 20I-K) 0.83 mm; median lobe distinctly narrowed and slightly asymmetric at apex; parameres elongate, almost symmetric, apically broadened; endophallus composed of one long and one short sclerite.
Female. Unknown.

Distribution: Nepal, Bagmati.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and is most similar to *P. psomus* described above in sharing similar forms of the antennal clubs, and the median lobe of the aedeagus being strongly extending apically. These two species can be separated only based on the slightly different position of the apical process of antennomeres 9, the relatively shorter metaventral processes with a different form of the apex, and the shorter ventral spine of the profemora of the new species.

Etymology: The new species is named after Ales Smetana, co-collector of the holotype.

Pselaphodes symmetricus sp. nov.
Figs 19B, 21A-L

Type material (3 specimens)**:** Holotype; MHNG-ENTO-44079; ♂; NEPAL, 'NEPAL: distr. Kathmandu: Phulcoki, 2500 m, 30.IV.84, Löbl - Smetana'. – Paratypes; MHNG-ENTO-44080; 1 ♀; NEPAL, same label data as holotype. – MHNG-ENTO-44081; 1 ♂; NEPAL, 'NEPAL (Prov. Bagmati), Gul Bhanjyang, 2600 m, 6.IV.81, Löbl & Smetana' (both paratypes in MHNG).

Type locality: Nepal, Kathmandu District, Phulchoki Hill, 2500 m alt.

Diagnosis of males: Length 3.01-3.15 mm. Antennomeres 9 slightly concave on mesal surface, antennomeres 10 with large projection at base. Metaventral processes moderately long, with pair of small triangular projection in addition to elongate processes. Protrochanters with slender ventral spine, profemora with blunt ventral spine, protibiae with large spine at apex; mesotrochanters with acute ventral spine, mesotibiae with small projection at apex. Median lobe of aedeagus symmetric, narrowed at apex; parameres short and symmetric.

Description: Male (Fig. 19B). Body reddish brown, BL 3.01-3.15 mm. Head longer than wide, HL 0.62-0.65 mm, HW 0.55-0.59 mm; each eye composed of about 40 facets. Antennomeres (Fig. 21A) 9-11 forming distinct club, antennomeres 10 with large projection at base. Pronotum (Fig. 21B) longer than wide, PL 0.61-0.64 mm, PW 0.56-0.61 mm, rounded at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.82-0.87 mm, EW 1.14-1.22 mm. Metaventral processes (Fig. 21C) moderately elongate, with pair of small triangular projection in addition to long processes. Protrochanters with slender ventral spine, profemora with blunt ventral spine (Fig. 21D), protibiae (Fig. 21E) with distinct spine at apex; mesotrochanters with acute ventral spine (Fig. 21F); mesotibiae with small projection at apex (Fig. 21G); metatrochanters and metafemora (Fig. 21H) simple. Abdomen broad at base and narrowing apically, AL 0.96-0.99 mm, AW 1.23-1.31 mm. Sternite IX semi-membranous, shape as in Fig. 21I. Length of aedeagus (Figs 21J-L) 0.59 mm; median lobe symmetric and stout, apex abruptly narrowed; parameres short, almost symmetric; endophallus composed of one long and one short sclerites.
Female. Each eye composed of about 22 facets; antennae simple. Measurements: BL 2.92 mm, HL 0.59 mm, HW 0.56 mm, PL 0.67 mm, PW 0.64 mm, EL 0.70 mm, EW 1.37 mm, AL 0.96 mm, AW 1.44 mm.

Distribution: Nepal, Bagmati.

Comparative notes: The new species is a member of the *P. bagmatius* species-group, and can be readily separated from all other congeners based on the more elongate antennomeres and elytra, the large basal projection of antennomeres 10 of the male, and the stout and symmetric median lobe of the aedeagus.

Etymology: The specific epithet refers to the symmetric form of the aedeagus of the new species.

Pselaphodes tmesisternus sp. nov.
Figs 22A, 23A-K

Type material (8 specimens)**:** Holotype; MHNG-ENTO-44082; ♂; NEPAL, 'E. NEPAL: KOSI Forêt S. Mangsingma, 2200-2600 m, 11-13.IV.1984, Löbl - Smetana' (MHNG). – Paratypes; MHNG-ENTO-44083 to 44086;2 ♂♂, 2 ♀♀; NEPAL, same label data as holotype. – MHNG-ENTO-44087; 1 ♂; NEPAL, same label data as holotype, except '2300 m, 13.IV.84'. – MHNG-ENTO-44088 & 44089; 1 ♂, 1 ♀; NEPAL, 'E. NEPAL: KOSI Col N-E Mangmaya, 2300 m, 6.IV.84, Löbl - Smetana' (all paratypes in MHNG).

Type locality: Nepal, Khandbari District, forest south of Mangsingma, 2200-2600 m alt.

Diagnosis of males: Length 2.93-3.01 mm; antennomeres 9 with disc-shaped process at apex, antennomeres

Fig 21. Male diagnostic features of *Pselaphodes symmetricus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A-B, D, F, H; 0.2 mm in C, J-L; 0.1 mm in E, G, I.

10 strongly constricted at apex and slightly constricted at base, antennomeres 10 slightly constricted at base; metaventral processes long; profemora with large blunt ventral spine, protibiae with small spine at apex; mesotrochanters with three ventral spines. Median lobe of aedeagus broad at apex, asymmetric; parameres short, broadened apically.

Description: Male (Fig. 22A). Body reddish brown, BL 2.93-3.01 mm. Head as long as wide, HL 0.59-0.60 mm, HW 0.59-0.60 mm; each eye composed of about 30 facets; with well-developed ocular canthus. Antennomeres (Fig. 23A) 9-11 forming distinct club, antennomeres 9 with disc-shaped process at apex, antennomeres 10 oblique, strongly constricted at apex and slightly constricted at base, antennomeres 11 constricted at base. Pronotum (Fig. 23B) about as long as wide, PL 0.67-0.69 mm, PW 0.66-0.67 mm, roundly

angulate at anterolateral margins, strongly constricted at apical third. Elytra wider than long, EL 0.70-0.71 mm, EW 1.20-1.22 mm. Metaventral processes (Fig. 23C) long, narrowing apically. Protrochanters with small spine, profemora with large blunt ventral spine (Fig. 23D), protibiae (Fig. 23E) with small spine at apex; mesotrochanters (Fig. 23F) with three ventral spines; metatrochanters and metafemora (Fig. 23G) simple. Abdomen broad at base and narrowing apically, AL 0.96-1.02 mm, AW 1.34-1.38 mm. Sternite IX semi-membranous, composed of three sclerites, shape as in Fig. 23H. Length of aedeagus (Figs 23I-K) 0.70 mm; median lobe broad and asymmetric; parameres short and broad apically, endophallus composed of two one long and one short sclerites.

Female. Each eye composed of about 25 facets; antennae simple. Measurements: BL 2.98-3.30 mm, HL 0.63-0.76 mm, HW 0.58-0.66 mm, PL 0.63-0.72 mm, PW 0.66-0.74 mm, EL 0.66-0.82 mm, EW 1.18-1.29 mm, AL 1.00-1.06 mm, AW 1.43-1.50 mm.

Distribution: Nepal, Koshi.

Comparative notes: The new species belongs to the *P. bagmatius* species-group, and can be readily separated from all other congeners based on the unique form of the male antennal clubs, the divided male sternite IX, and the configuration of the aedeagus.

Etymology: The specific epithet refers to the divided male sternite IX of the new species.

Fig 22. Dorsal habitus of *Pselaphodes* males. (A) *P. tmesisternus* sp. nov. (B) *P. unicornis*. Scale bars: 1 mm.

New records

***Pselaphodes spinosus* Champion, 1925**

Pselaphodes spinosus Champion, 1925: 261.
Labomimus championi Jeannel, 1960: 454.
Pselaphodes championi. – Yin & Li, 2015: 340, **comb. & syn. n.**

Type material examined: Lectotype; ♂; INDIA, see Yin & Li (2015: 340).

Other material examined (9 specimens)**:** 4 ♂♂, 1 ♀; 'NEPAL, distr. Kathmandu, Godwari, 1600 m, Löbl, 31.III.84' (MHNG, SNUC). – 1 ♂; 'Népal, 24.III.82, Sheopuri, 2700 m, near Kathmandu, Rougemont' (MHNG). – 1 ♂; 'NEPAL, Khandbari, District, Dunge Dara N of Tumlingtarm, 23.III.82, 1100 m, A. & Z. Smetana' (MHNG). – 1 ♂; 'NEPAL, NEPAL (Prov. Bagmati), Burlang Bhanjyang, 2600 m, 5.IV.81, Löbl & Smetana' (MHNG). – 1 ♂; 'NEPAL, Lalitpur, Distr. Phulcoki, 2650 m, 13.X.83, Smetana & Löbl' (MHNG).

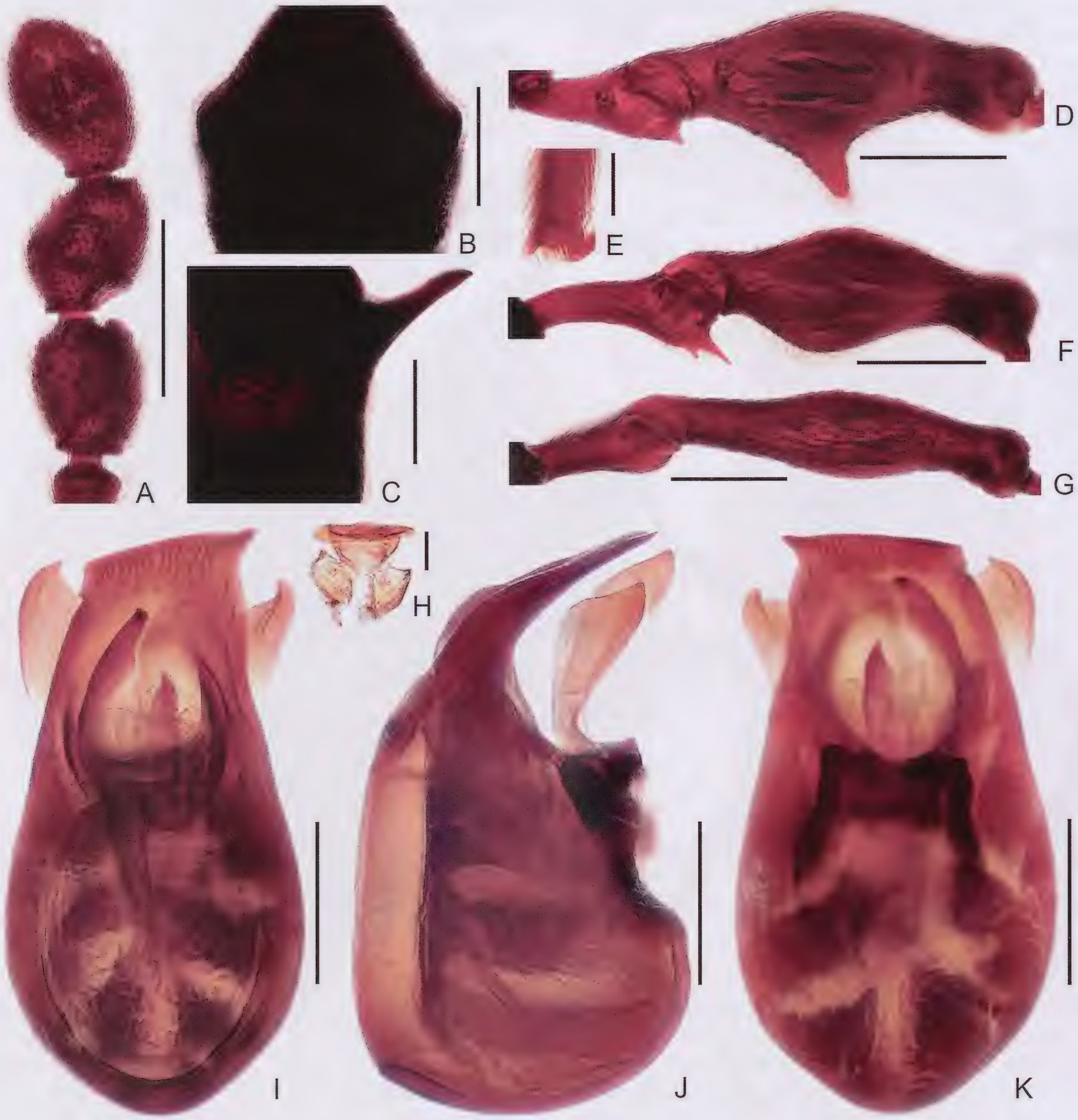

Fig 23. Male diagnostic features of *Pselaphodes tmesisternus* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, in lateral view. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Metatrochanter and metafemur. (H) Sternite IX. (I-K) Aedeagus, in dorsal (I), lateral (J), and ventral (K) view. Scale bars: 0.3 mm in A-B, D, F-G; 0.2 mm in C, I-K; 0.1 mm in E, H.

Comments: This species was originally known from northern India, later recorded from Xizang, China, and is here reported for the first time from Nepal. Males are easily recognizable based on the unique forms of the antennal club and aedeagus (see Yin & Li 2015; Huang *et al.*, 2018). The populations of Nepal show little variation in all diagnostic features, and thus can be easily identified.

Distribution: China: Xizang; India: Uttarakhand; Nepal: Bagmati, Koshi (**New County Record**).

***Pselaphodes unicornis* Bekchiev & Hlaváč, 2013**

Figs 22B, 24A-L

Pselaphodes unicornis Bekchiev & Hlaváč, 2013: 497.

Type material examined: Holotype; ♂; NEPAL, 'Nepal, Parbat, Ghorepani, *Rhodendron* forest, 2860 m, 13.10.2006, leg. D. Bechev / HOLOTYPUS *Lasinus unicornis* sp. n. det. Bekchiev & Hlaváč 2013 / collection NMNH-Sofia, Bulgaria' (NMNHS). – Paratype; 1 ♀; NEPAL, 'Nepal, Langtang Valley. Lama longe, 2500-2800 m, 25.10.1984, leg. P. Beron / HOLOTYPUS *Lasinus unicornis* sp. n. det. Bekchiev

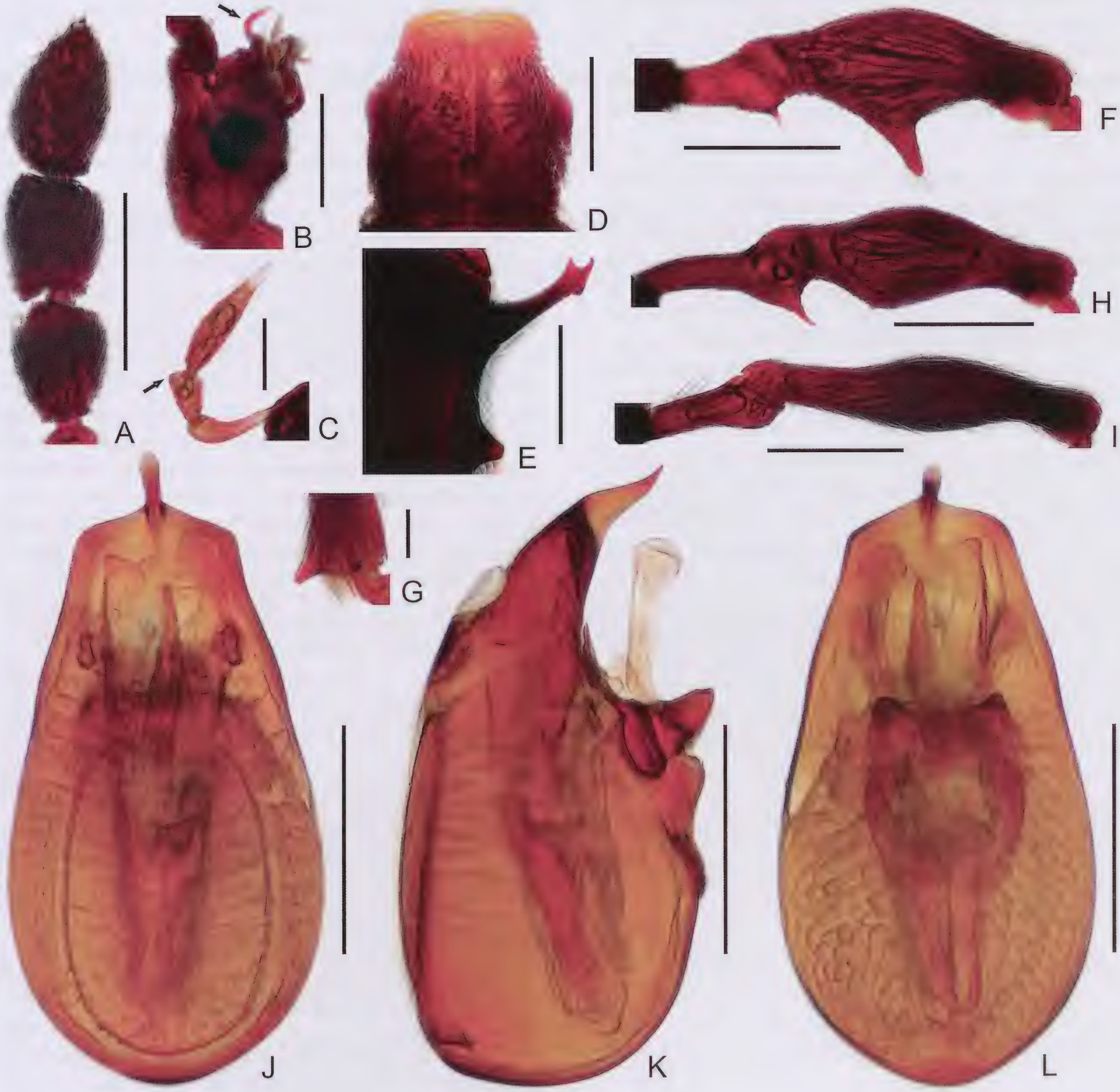

Fig 24. Male diagnostic features of *Pselaphodes unicornis*. (A) Antennal club. (B) Head, in lateral view. (C) maxillary palpus. (D) Pronotum. (E) Metaventral process. (F) Protrochanter and profemur. (G) Apex of protibia. (H) Mesotrochanter and mesofemur. (I) Metatrochanter and metafemur. (J-L) Aedeagus, in dorsal (J), lateral (K), and ventral (L) view. Scale bars: 0.3 mm in A, B, D, F, H, I; 0.2 mm in E, J-L; 0.1 mm in C; 0.05 mm in G.

& Hlaváč 2013 / collection NMNH-Sofia, Bulgaria' (NMNHS).

Other material examined (21 specimens)**:** 1 ♂, 1 ♀; 'NEPAL, Parbat Distr. Ghoropani, Pass N slope, 2700 m, 6.X.1983, Smetana & Löbl' (MHNG). – 1 ♂; same data as for precedent, except '2750 m, 6.X.1983' (MHNG). – 1 ♂; same data as for precedent, except '2850 m, 9.X.1983' (MHNG). – 1 ♀; same data as for precedent, except '3100 m, 7.X.1983' (MHNG). – 2 ♀♀; same data as for precedent, except '3050-3100 m, 8.X.1983' (MHNG). – 6 ♂♂, 3 ♀♀; 'NEPAL, Khandbari District, above Tashigaon, 3600 m, 6.IV.1982, A. & Z. Smetana' (MHNG). – 1 ♂; 'NEPAL, Khandbari District, "Bakan" W of Tashigaon, 3200 m, 3.IV.1982, A. & Z. Smetana' (MHNG). – 1 ♂, 1 ♀; 'NEPAL, Mustang Distr., Lete, 2550 m, 2.X.83, Smetana & Löbl' (MHNG). – 2 ♀♀; 'NEPAL, Mustang Distr., 2 km N Kalopani, 2550 m, 1.X.83, Smetana & Löbl' (MHNG).

Comments: This species is a member of the *P. bagmatius* species-group, and widely distributed in Nepal. Males can be readily identified based on the unique sexual characters, and the aedeagus. The females can be recognized only by an association with a male.

Distribution: Nepal: Dhaulagiri, Bagmati, Koshi.

ACKNOWLEDGMENTS

We thank Giulio Cuccodoro (MHNG) for issuing a loan of the material used in this paper. Rostislav Bekchiev (NMHNS) provided the type series of *Pselaphodes unicornis* for our examination. Christopher Carlton (Louisiana State University, USA) and Rostislav Bekchiev reviewed the draft manuscript and provided helpful comments. The present study was provided by the National Natural Science Foundation of China (No. 31872965), the Shanghai 'Phosphor' Science Foundation, China (19QA1406600), and a visiting scientist award from the Muséum d'histoire naturelle, Geneva to ZWY.

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Two new species and new records of the *Pselaphodes*-complex of genera from China (Coleoptera: Staphylinidae: Pselaphinae)

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Abstract: Two new species of the *Pselaphodes*-complex of genera, *Labomimus consimilis* sp. nov. and *Pselaphodes lianghongbini* sp. nov., are described from Xizang, southwestern China. New collecting data are provided for *P. cuonaus* Yin, Li & Zhao, 2011 and *P. monoceros* Yin & Hlaváč, 2013 in Xizang, and *Taiwanophodes minor* Hlaváč, 2003 in Hunan.

Keywords: Taxonomy - *Pselaphodes* complex of genera - new species - new records - China.

INTRODUCTION

Through a courtesy from Dr Hong-Bin Liang of the Institute of Zoology, Chinese Academy of Sciences (IZCAS), I recently had an opportunity to examine the pselaphine beetles collected during two 2016 insect surveys in Xizang and Hunan Provinces conducted by IZCAS teams. The result revealed two new species of the genera *Labomimus* Sharp, 1883 and *Pselaphodes* Westwood, 1870, and new collecting records of several species of *Pselaphodes* and *Taiwanophodes* Hlaváč, 2003, which is reported in this paper. The taxonomic histories and diversities of these genera in Asia were summarized or supplemented by Hlaváč (2003), Yin *et al*. (2012), Yin & Li (2015), Huang *et al*. (2018a, b), Huang & Yin (2019), Zhang & Yin (2019), and Zhang *et al*. (2019).

MATERIAL AND METHODS

The material used in this paper is housed in the Institute of Zoology, Chinese Academy of Sciences (IZCAS), and the Insect Collection of Shanghai Normal University (SNUC). The original Chinese text is quoted verbatim, followed by English translation placed in parentheses; the letters 'D' or 'N' after the date mean the specimen was collected by daytime or in the night, respectively, and 'D2', for example, means the second collecting site of that day.

Dissected parts were preserved in Euparal on plastic slides that were placed on the same pins with the specimens. The habitus images were taken using a Canon 5D Mark III camera with a Canon MP-E 65mm f/2.8 1-5X Macro Lens, and a Canon MT-24EX Macro Twin Lite Flash used as the light source. Images of the morphological details were produced using a Canon G9 camera mounted to an Olympus CX31 microscope under transmitted light. Zerene Stacker (version 1.04) was used for image stacking. All images were optimized and grouped into plates using Adobe Photoshop CS5 Extended.

TAXONOMY

Labomimus consimilis sp. nov.

Figs 1A, 2A-J

Type material: Holotype; IOZ(E)2058770; ♂; CHINA, '西藏墨脱县亚让电站附近, 2016.VI.17D, 720 m, N° 29.2973, E° 95.2534, 采集人: 梁红斌 (China: Xizang, Motuo County, near Ya-Rang Power Station, Hong-Bin Liang leg.)' (IZCAS).

Type locality: Motuo County, Xizang, China.

Diagnosis: Male: Body length about 2.6 mm. Antennomere 9 strongly dilated, antennomere 10 subtrapezoidal, antennomere 11 curved. Metaventral processes short and broad, narrowed at apex. Protrochanters with sharp, thin ventral spine; mesotrochanters with small ventral spine. Median lobe of aedeagus asymmetric, strongly narrowed apically; parameres elongate and slender; endophallus comprised of one sclerotized plate bearing two elongate branches. Female: unknown.

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Description: Male (Fig. 1A). Body reddish brown, body length 2.64 mm. Head slightly broader than long, length from anterior clypeal margin to base 0.50 mm, width across eyes 0.52 mm; each eye composed of about 40 facets; with rather short ocular canthus. Antennomeres 9-11 forming distinct club (Fig. 2A); antennomere 9 strongly dilated, its dorsal surface broadly impressed at apical half, with two tufts of setae, antennomere 10 expanded, sub-trapezoidal, antennomere 11 elongate, its mesal surface strongly impressed at basal half. Maxillary palpomeres 2-4 roundly broadened on lateral margin. Pronotum (Fig. 2B) as long as wide, length along midline and maximum width 0.49 mm, anterolateral margins rounded, narrowing toward apex at apical 1/3. Elytra strongly transverse, length along suture 0.77 mm, maximum width 1.31 mm. Metaventral processes (Fig. 2C) relatively short, roundly narrowed at apex. Protrochanters (Fig. 2D) with thin, sharp ventral spine, profemora simple; mesotrochanters (Fig. 2E) with short ventral spine, mesofemora simple; metatrochanters and metafemora (Fig. 2F) simple. Abdomen broad at base and narrowing apically, length of dorsally visible part along midline 0.88 mm, maximum width 1.02 mm. Semi-membranous sternite IX (Fig. 2G) elongate. Length of aedeagus (Figs 2H-J) 0.47 mm; median lobe asymmetric, strongly narrowing apically; parameres elongate and slender, apices bent ventrally; endophallus composed of one sclerotized plate bearing two elongate branches.

Female. Unknown.

Fig 1. Male habitus of *Labomimus consimilis* sp. nov. (A) and *Pselaphodes lianghongbini* sp. nov. (B). Scale bars: 1 mm.

Comparative notes: The male of *Labomimus consimilis* is most similar to those of *L. qiujianyuae* Zhang, Li & Yin, 2019 from Xizang, and *L. wuchaoi* Zhang, Li & Yin, 2019 from Yunnan in sharing a curved antennomere 11, and a dilated antennomere 9 bearing tufted setae on the dorsal surface. It differs from *L. qiujianyuae* in the expanded, sub-trapezoidal antennomere 10 (antennomere 10 elongate and sub-cylindrical in *L. qiujianyuae*), the much shorter metaventral processes, the spinose protrochanter (protrochanter simple in *L. qiujianyuae*), and the much narrower apex of the median lobe and relatively much

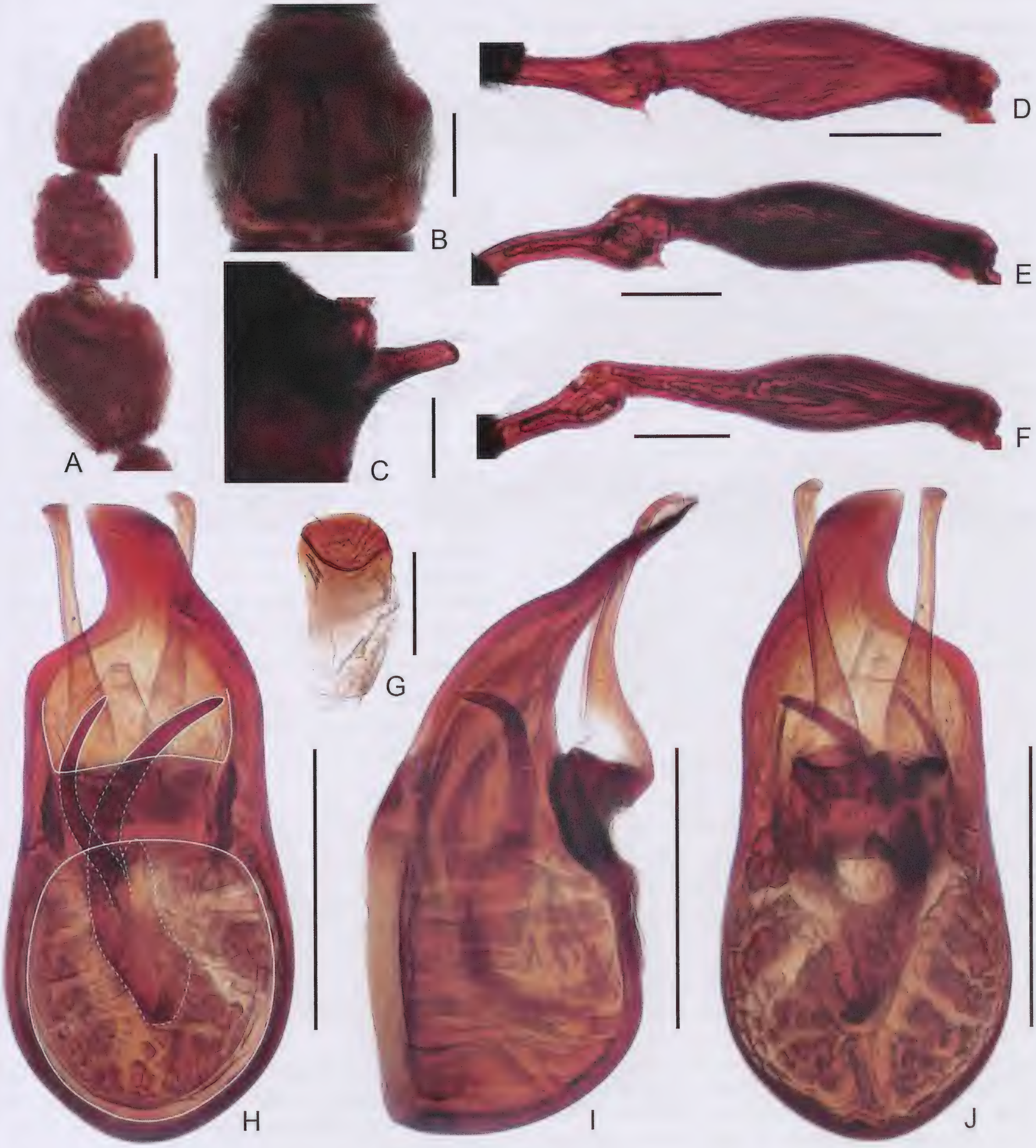

Fig 2. Male diagnostic features of *Labomimus consimilis* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, lateral. (D) Protrochanter and profemur. (E) Mesotrochanter and mesofemur. (F) Metatrochanter and metafemur. (G) Sternite IX. (H-J) Aedeagus, dorsal (H), lateral (I), and ventral (J). Scale bars: all 0.2 mm, except 0.1 mm in G.

longer parameres of the aedeagus; from *L. wuchaoi* in the much smaller body size (2.64 mm vs. 3.26-3.34 mm), the more elongate antennomere 9, the shorter metaventral processes, and the narrowed apex of the aedeagal median lobe (in *L. wuchaoi*, the aedeagus has the median lobe with a broad apex that is strongly impressed at the anterior margin).

Distribution: China: Xizang.

Etymology: The specific epithet '*consimilis*' (very similar) is an adjective referring to the morphological resemblance of the new species to the two related congeners.

Pselaphodes lianghongbini sp. nov.

Figs 1B, 3A-L

Type material: Holotype; IOZ(E)2058749; ♂; CHINA, '西藏错那县勒乡, 边防六连公路4.5 km处, 2016. VI.7D, 2670 m, N° 27.8202, E° 91.7576, 采集人: 梁红斌 (China: Xizang, Cuona County, Le Township, 4.5 km of Bian-Fang-Liu-Lian Highway, Hong-Bin Liang leg.)' (IZCAS). – Paratypes; IOZ(E)2058745 to 2058747, 2058751; 4 ♀♀; CHINA, same label data as holotype (IZCAS).

Type locality: Le Menba Ethnic Township, Cuona County, Xizang, China.

Diagnosis: Male: Body length about 3.6 mm. Antennomere 9 with disc-shaped process near apex, antennomere 10 with round projection at base. Metaventral processes short and broad, narrowed apicad and with round apex. Profemora robust, with large triangular ventral spine, protibiae with distinct apical projection; mesotrochanters with small ventral spine, mesotibiae with slender spur at apex; metacoxae with blunt ventral projection. Median lobe of aedeagus almost symmetrical, narrowing apically and with round apex; parameres with roundly broadened apical half; endophallus comprised of two sclerites. Female: identifiable only by association with male.

Description: Male (Fig. 1B). Body reddish brown, body length 3.63 mm. Head elongate, length from anterior clypeal margin to base 0.73 mm, width across eyes 0.44 mm; each eye composed of about 30 facets; with short ocular canthus. Antennomeres 9-11 forming distinct club (Fig. 3A); antennomere 9 with disc-shaped process near apex, antennomere 10 constricted at base, with round, lamina-like projection at base. Maxillary palpomeres 2-4 strongly protuberant and stemmed on lateral margin. Pronotum (Fig. 3B) longer than wide, length along midline 0.73 mm, maximum width 0.66 mm, roundly angulate at anterolateral margins, narrowing toward apex at apical 2/5. Elytra wider than long, length along suture 1.0 mm, maximum width 1.34 mm. Metaventral processes (Fig. 3C) short and broad, roundly narrowed at apex; with pair of short tubercles above metacoxae. Profemora (Fig. 3D) thickened, with large triangular ventral spine, protibiae (Fig. 3E) with large projection at apex; mesotrochanters (Fig. 3F) with small ventral tubercle; mesotibiae (Fig. 3G) with slender spur at apex; metacoxae (Fig. 3H) with blunt ventral projection. Abdomen broad at base and narrowing apically, length of dorsally visible part along midline 1.17 mm, maximum width 1.32 mm. Semi-membranous sternite IX (Fig. 3I) nearly oval. Length of aedeagus (Figs 3J-L) 0.67 mm; median lobe almost symmetric, narrowing apically and with round apex; parameres narrowed at base and roundly broadened at apical half; endophallus composed of one elongate and one shorter sclerites.

Female. Each eye composed of about 25 facets; antennae simple; mesotrochanters with large, triangular ventral spine; metaventral processes much shorter, subtriangular; lacking tubercles above metacoxae. Measurements (as for male): body length 3.61-3.88 mm, length/width of head 0.74-0.78/0.59-0.63 mm, length/width of pronotum 0.74-0.75/0.64-0.68 mm, length/width of elytra 0.90-0.96/1.35-1.38 mm, length/width of abdomen 1.22-1.40/1.46-1.55 mm.

Comparative notes: Based on the structure of the modification of the male antennal club and the endophallus of the aedeagus, the new species is placed as a member of the *P. bagmatius* species-group containing 15 species from Nepal (termed in Huang & Yin, 2019). *Pselaphodes lianghongbini* can be readily separated from all Nepalese species by a unique combination of the structure of the antennal club, spination of the legs, form of the metaventral processes, as well as the almost symmetric aedeagus.

Distribution: China: Xizang.

Etymology: The specific epithet is dedicated to Dr Hong-Bin Liang, collector of the type series of the new species.

Pselaphodes cuonaus Yin, Li & Zhao, 2011

Pselaphodes cuonaus Yin, Li & Zhao, 2011: 465.

Material examined: 9 ♂♂, 1 ♀; CHINA, '西藏错那县勒乡, 边防六连公路13 km处, 2016.VI.4D2, 3356 m, N° 27.8050, E° 91.7620, 采集人: 梁红斌, 振网 (China: Xizang, Cuona County, Le Township, 13 km of Bian-Fang-Liu-Lian Highway, Hong-Bin Liang leg., beating)' (IZCAS, SNUC).

Comments: The male of this species can be readily recognized based on the unique modification of the antennal clubs, which was illustrated in Yin *et al.* (2011: 468, fig. 16).

Distribution: This species was known from a single male collected at Le Township. The present new record confirms the presence of this species in Cuona.

Pselaphodes monoceros Yin & Hlaváč, 2013

Pselaphodes monoceros Yin & Hlaváč (in: Yin *et al.*, 2013: 57)

Material examined: 1 ♂; CHINA, '西藏错那县勒乡, 边防六连公路4.5 km处, 2016.VI.7D, 2670 m, N° 27.8202, E° 91.7576, 采集人: 梁红斌 (China: Xizang, Cuona County, Le Township, 4.5 km of Bian-Fang-Liu-Lian Highway, Hong-Bin Liang leg.)' (IZCAS).

Comments: The male of this species is most similar to that of *P. unicornis* Bekchiev & Hlaváč, 2013 and *P. corniger* Huang & Yin, 2019 from Nepal based on the modified, protuberant clypeus (Bekchiev & Hlaváč, 2013; Huang & Yin, 2019). It differs from *P. unicornis* in the different shape of the metaventral processes and a much stouter aedeagus, and from *P. corniger* in the presence of an apical spur of protibiae (protibiae with

Fig 3. Male diagnostic features of *Pselaphodes lianghongbini* sp. nov. (A) Antennal club. (B) Pronotum. (C) Metaventral process, lateral. (D) Protrochanter and profemur. (E) Apex of protibia. (F) Mesotrochanter and mesofemur. (G) Apex of mesotibia. (H) Metacoxa, metatrochanter and metafemur. (I) Sternite IX. (J-L) Aedeagus, dorsal (J), lateral (K), and ventral (L). Scale bars: 0.3 mm in A-D, F, H; 0.2 mm in J-L; 0.1 mm in E, G, I.

a preapical spur in *P. corniger*), a different form of the metaventral processes, and the almost symmetric median lobe of the aedeagus (aedeagus strongly asymmetric in *P. corniger*).

Distribution: This species was described from five males and one female collected from Le Township, at an altitude of 2500 m. Its distribution is currently restricted to Le Township of Cuona County.

Taiwanophodes minor Hlaváč, 2003

Taiwanophodes minor Hlaváč, 2003: 292; Yin *et al*., 2012: 83.

Material examined: 1 ♂, 1 ♀; CHINA, '湖南张家界市武陵源区文丰村, 2016.IV.22N, 376 m, 29.3385°N, 110.5898°E, 采集人: 梁红斌 赵凯东, 灯诱 (China: Hunan, Zhangjiajie City, Wulingyuan District, Wenfeng Village, Hong-Bin Liang & Kai-Dong Zhao leg., light trap)' (IZCAS).

Comments: This species can be recognized and readily separated from its only congener, *Taiwanophodes magnus* Bekchiev, 2010 from northern Vietnam by the enlarged antennomere 10 with a ventral impression, and the markedly elongate ventral lobe on the left side of the aedeagal median lobe. In contrast, *T. magnus* has the antennomere 10 bearing a distinct projection at the apex, the antennomere 11 is strongly constricted at the base, and the median lobe of the aedeagus is in general gradually narrowing toward the apex (Bekchiev, 2010: figs 2-3, 7-8). The population from Hunan shows little morphological variation compared with those from Taiwan and Hainan.

Distribution: The species was originally described from Taiwan, subsequently recorded from Hainan, and is here newly recorded from Hunan (ca. 1100 km north of Hainan) (**New provincial record**).

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Notes on some *Palliduphantes* Saaristo & Tanasevitch, 2001, with the description of a new species from the Iberian Peninsula (Araneae: Linyphiidae)

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Abstract: A revised diagnosis of the genus *Palliduphantes* Saaristo & Tanasevitch, 2001 is given and a new species, *Palliduphantes curvus* sp. nov., is described from Spain and Portugal. Eight new combinations are proposed: *Palliduphantes bigerrensis* (Simon, 1929), *P. constantinescui* (Georgescu, 1989), *P. corfuensis* (Wunderlich, 1995), *P. eleonorae* (Wunderlich, 1995), *P. fagei* (Machado, 1939), *P. garganicus* (Caporiacco, 1951), *P. ligulifer* (Denis, 1952) and *P. zaragozai* (Ribera, 1981), all comb. nov. ex *Lepthyphantes* Menge, 1866. New male and female specimens of *P. corfuensis* comb. nov. are described and illustrated.

Keywords: Taxonomy - spiders - Micronetinae - *Lepthyphantes* - new combinations - Spain - Portugal.

INTRODUCTION

The genus *Palliduphantes* Saaristo & Tanasevitch, 2001 was established by Saaristo & Tanasevitch (2001) during their re-organization of the extremely large and heterogeneous genus *Lepthyphantes* Menge, 1866 (see Saaristo & Tanasevitch, 1996, 1999, 2000, 2001, 2003a, b, 2004; Tanasevitch, 2001; Tanasevitch & Saaristo, 2006; etc.), and this work is still unfinished. At first, Saaristo and Tanasevitch (2001) placed into *Palliduphantes* 48 species mainly from the *pallidus*-species group *sensu* Saaristo & Tanasevitch (1993). An additional 11 species were described under *Palliduphantes* or transferred from other genera by 2019 (see World Spider Catalog, 2019). Recently, *P. corsicos* (Wunderlich, 1980) and *P. gladiola* (Simon, 1884) were added, transferred from *Lepthyphantes* and *Mansuphantes* Saaristo & Tanasevitch, 1996, respectively (Tanasevitch, 2019). Ten new *Palliduphantes* were described from Morocco (Barrientos *et al*., 2019). Today the genus is thus known to contain 71 species. Another new *Palliduphantes* from Spain and Portugal is described below; eight species are here additionally transferred from *Lepthyphantes* on the basis of a revised diagnosis of the genus *Palliduphantes*.

MATERIAL AND METHODS

This paper is based on spider material kept at the Muséum d'histoire naturelle de Genève, Switzerland (MHNG). Senglet's sample numbers are given in square brackets. Specimens preserved in 70% ethanol were studied using a MBS-9 stereomicroscope. The terminology of copulatory organs mainly follows that of Merrett (1963) and Saaristo & Tanasevitch (1996). The chaetotaxy is given in a formula, e.g., Ti I: 2-1-1-0, which means that tibia I has two dorsal spines, one pro-, one retrolateral spine, and no ventral spines (the apical spines are disregarded). The sequence of leg segment measurements is as follows: femur+patella+tibia+metatarsus+tarsus. All measurements are given in mm. All scale bars in the figures correspond to 0.1 mm.

Abbreviations

BS	bald swelling
EP	embolus proper *sensu* Saaristo (1971)
DPS	distal part of scape *sensu* Saaristo & Tanasevitch (1996)
FG	Fickert's gland
L	lamella characteristica
LL	lateral lobes
LW	lateral wall *sensu* Saaristo & Tanasevitch (1996)
Mt	metatarsus
PMP	posterior median plate *sensu* Helsdingen *et al.* (1977)
PS	proscape *sensu* Saaristo & Tanasevitch (1996)
R	radix
Re	receptacle
St	stretcher

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TA terminal apophysis
Ti tibia
Th thumb *sensu* Saaristo & Tanasevitch (1996)
TmI position of trichobothrium on metatarsus I

RESULTS

Order Araneae Clerck, 1757
Family Linyphiidae Blackwall, 1859
Subfamily Micronetinae Hull, 1920

Palliduphantes Saaristo & Tanasevitch, 2001

Type species: *Linyphia pallida* O. Pickard-Cambridge, 1871, by original designation.

Diagnosis: The diagnosis given below is a slightly corrected and supplemented version of the genus diagnosis provided by Saaristo & Tanasevitch (2001).

1) Medium sized, pale, often cavernicolous micronetine spiders, total length 1.3-2.5, seldom up to 3.0 mm.
2) Abdomen of one color, grey, very seldom with an indistinct dorsal pattern of pale transverse stripes in dark-colored specimens.
3) General pattern of chaetotaxy as follows: Ti I: 2-1-1-0, II: 2-0(1)-1-0, III: 2-0-0(1)-0, IV: 2-0-0-0; Mt I-III(IV): 1-0-0-0. Tm I: 0.16-0.26, no trichobothrium on Tm IV.
4) Palpal tibia of male usually short, conspicuously swollen, bearing one strong dorsal spine on patella and tibia.
5) Paracymbium large, its posterior and anterior pockets (*sensu* Saaristo & Tanasevitch, 1996: 167) transformed to two teeth or tooth-like outgrowths.
6) Pit hook (= distal suprategular apophysis in male palp of Erigoninae; not illustrated in this paper) relatively long, curved, blunt or sharply pointed.
7) Radix oblong, Fickert's gland present.
8) Main trunk of lamella characteristica long and narrow, slightly bent or S-shaped.
9) Terminal apophysis usually bipartite, seldom fan- or broom-shaped.
10) Embolus with a trunk-like main body, relatively long, weak, embolus proper bifid.
11) Epigyne protruded, its side walls drawn into plate-like extensions between which lies the scapus.
12) Proscapus long and narrow, its median part short or reduced. Distal part of scape often lacking distinct lateral lobes, stretcher present or reduced.
13) Posterior median plate present.

Taxonomic remarks: An examination of the *Lepthyphantes* (*sensu lato*) fauna of southern Europe revealed that, on the basis of the diagnosis given above, at least eight species actually belong to *Palliduphantes,* i.e. *Palliduphantes bigerrensis* (Simon, 1929), *P. constantinescui* (Georgescu, 1989), *P. corfuensis* (Wunderlich, 1995), *P. eleonorae* (Wunderlich, 1995), *P. fagei* (Machado, 1939), *P. garganicus* (Caporiacco, 1951), *P. ligulifer* (Denis, 1952) and *P. zaragozai* (Ribera, 1981), all comb. nov. ex *Lepthyphantes*.

Species included: The genus currently includes 80 species (including the new species and new combinations), distributed mainly in the Mediterranean.

Palliduphantes curvus sp. nov.

Figs 1-7

Holotype: Male [7135]; SPAIN, Valencia, La Albufera; 16.VI.1971; leg. A. Senglet.

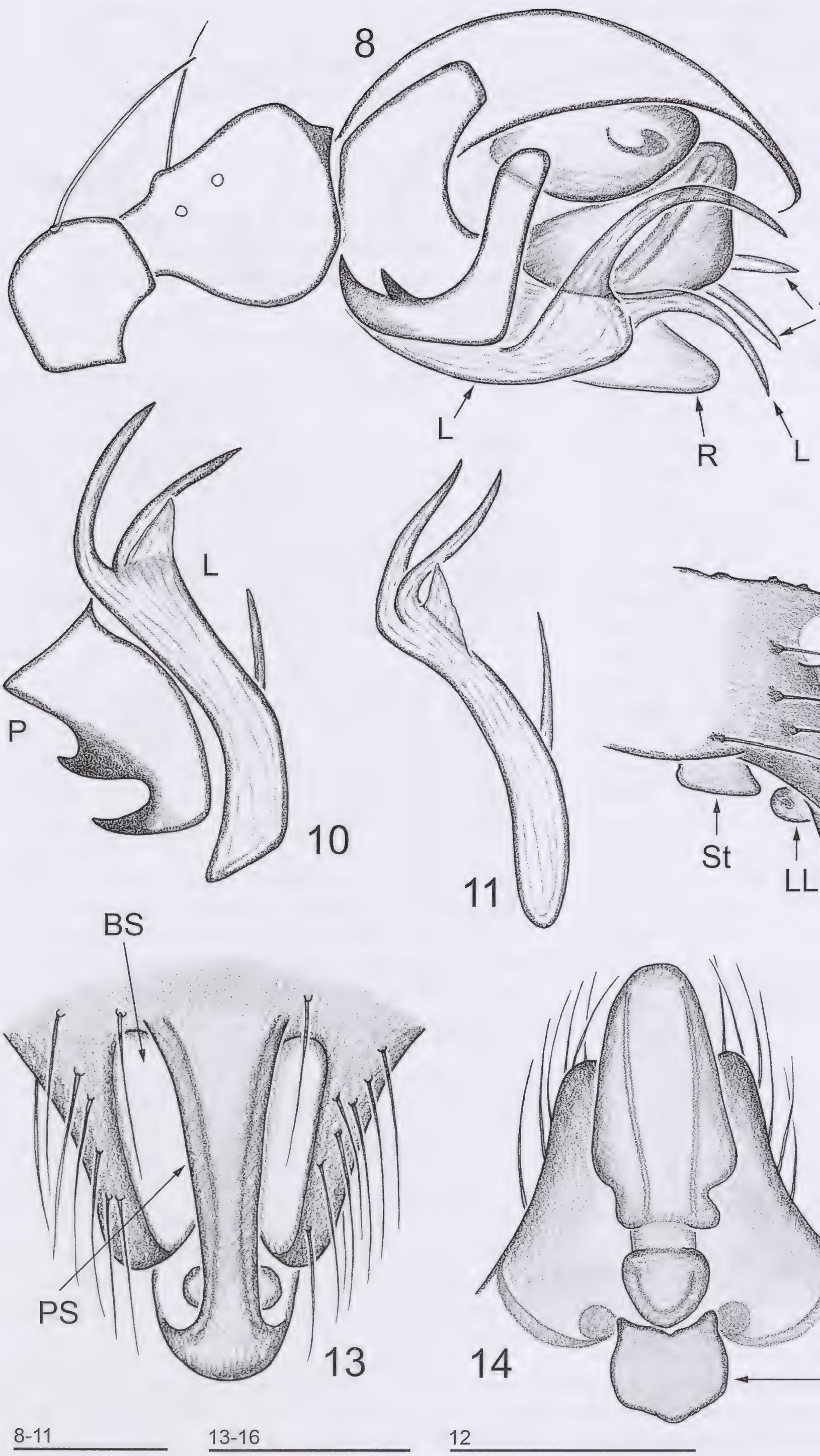
Paratype: 3 males, 1 female; collected together with the holotype. – 1 male [7141]; Valencia, Montroy (= Montroi), 22.VI.1971; leg. A. Senglet. – 1 male [7142]; Requena-Chera, 23.VI.1971; leg. A. Senglet. – 1 male, 1 female [7137]; Alicante, Elda; 19.VI.1971; leg. A. Senglet. – 1 male [6978]; PORTUGAL, Vila Real, Cortico, Montalegre; 30.VIII.1969; leg. A. Senglet.

Diagnosis: The new species clearly differs from all known congeners by the distinctive shape of the lamella characteristica which has a specifically bent lower branch (Figs 1, 3-4). The epigyne resembles that of many congeners, particularly *P. cadiziensis* (Wunderlich, 1980), *P. kalaensis* (Bosmans, 1985) and *P. yakourensis* Bosmans, 2006, but it can be distinguished by the very short distal part of the scape and by the oval posterior median plate (Figs 5, 7). The epigyne is also similar to that of *P. corfuensis* comb. nov. (see below), but is clearly distinguished by the absence of a bald swelling on the lateral walls, as well as by the reduced median and distal parts of the scape (Figs 5-7 cf. Figs 13-16).

Etymology: The specific epithet is a Latin adjective referring to the bent lower branch of the lamella characteristica.

Description: *Male holotype*. Total length 2.00. Carapace unmodified, 0.93 long, 0.75 wide, yellow. Chelicerae 0.38 long. Legs yellow. Leg I 4.56 long (1.20+0.28+1.23+1.10+0.75), IV 4.29 long (1.13+0.28+1.15+1.10+0.63). Chaetotaxy. FeI: 0-1-0-0, II-IV: 0-0-0-0; TiI: 2-1-1-0, TiII: 2-0-1-0, TiIII-IV: 2-0-0-0; MtI-III: 1-0-0-0, MtIV spineless. Length of tibial spines 3-4 diameters of corresponding leg segment. TmI 0.18. Metatarsus IV without trichobothrium. Palp (Figs 1-4): Patella small, rounded, with a long, strong spine dorsally. Tibia slightly widened dorso-ventrally. Paracymbium relatively large, its posterior and anterior pockets (*sensu* Saaristo & Tanasevitch, 1996: 167) tooth-shaped, dark. Lamella characteristica large, gently curved, distally tapering, its apex obliquely truncate, its short and pointed branch mesally bent by 90°. Embolus small, with elongated main body; embolus proper bifid, thumb present. Terminal apophysis composed of two long, slender, almost transparent branches. Abdomen 1.13 long, 0.65 wide, pale grey.

Figs 1-7. *Palliduphantes curvus* sp. nov., details of palp and epigyne structure; male (1-4) and female (5-7) paratypes from Elda. (1) Right palp, retrolateral view. (2) Paracymbium, retrolateral view. (3) Embolic division, ventral view. (4) Lamella characteristica, dorsal view. (5-7) Epigyne, lateral, ventral and dorsal view, respectively.



Figs 8-16. *Palliduphantes corfuensis* (Wunderlich, 1995) comb. nov., details of palp and epigyne structure; male (8-12) and female (13-16). (8) Right palp, retrolateral view. (9) Paracymbium, retrolateral view. (10) Paracymbium and lamella characteristica, ventral view. (11) Lamella characteristica, ventral view. (12) Embolus, ventro-retrolateral view. (13-15) Epigyne, ventral, dorsal and lateral view, respectively. (16) Distal part of scape and posterior median plate, ventral view.

Female paratype from La Albufera. Total length 2.38. Carapace 1.00 long, 0.80 wide. Chelicerae 0.40 long. Leg I 4.78 long (1.28+0.30+1.25+1.25+0.70), IV 4.63 long (1.25+0.28+1.20+1.20+0.70). TmI 0.18. Abdomen 1.50 long, 1.03 wide. Epigyne (Figs 5-7) distinctly protruded, proscape long and thin. Distal part of scape very small, stretcher and lateral lobes reduced. Posterior median plate oval. Receptacles small, beanlike. Body coloration and chaetotaxy as in male.

Variability: The total length in male specimens examined ranges from 1.95 to 2.03, in female specimens from 2.25 to 2.28. Dark-colored specimens have an indistinct dorsal abdominal pattern composed of narrow, pale transverse stripes on a grey background. No noteworthy variation in the genitalia of both sexes was found.

Distribution: Known only from four localities in Spain and from one locality in Portugal.

Palliduphantes corfuensis (Wunderlich, 1995) comb. nov.

Figs 8-16

Remarks: This species was described from Corfu, Greece by Wunderlich (1995), and, apart from a record from the same island by Lecigne (2013), not reported since the original description. A few specimens of this species, collected by Antoine Senglet in 1972 from Corfu, were recently found in the MHNG and are described below.

Material examined: 4 males, 6 females [7281]; GREECE, Corfu, Loutses; 20.IX.1972; leg. A. Senglet.

Description: *Male*. Total length 2.05. Carapace unmodified, 0.88 long, 0.70 wide, yellow. Chelicerae 0.33 long. Legs pale yellow. Leg I 4.78 long (1.20+0.28+1.30+1.20+0.80), IV 4.70 long (1.15+0.30+1.25+1.25+0.75). Chaetotaxy. FeI: 0-1-0-0, II-IV: 0-0-0-0; TiI: 2-1-1-0, TiII: 2-0-1-0, TiIII-IV: 2-0-0-0; MtI-III: 1-0-0-0, MtIV spineless. Length of spines 3-3.5 diameters of corresponding leg segment. TmI 0.16. Metatarsus IV without trichobothrium. Palp (Figs 8-12): Patella with a stout dorsal spine. Tibia short, unmodified. Paracymbium relatively large, its posterior and anterior pockets (*sensu* Saaristo & Tanasevitch, 1996) tooth-shaped, dark. Lamella characteristica deeply bifurcate distally, its main trunk with a flat triangular outgrowth at bifurcation and with a long, sable-shaped branch in the middle. Embolus small, weakly sclerotized, embolus proper bifid. Terminal apophysis bipartite. Abdomen 1.18 long, 0.70, pale grey. *Female*. Total length 2.00. Carapace 0.80 long, 0.65 wide, yellow, with a narrow grey margin and indistinct, grey, radial stripes. Chelicerae 0.35 long. Leg I 4.34 long (1.13+0.30+1.13+1.03+0.75), IV 4.07 long (1.08+0.28+1.03+1.00+0.68). TmI 0.19. Abdomen 1.35 long, 0.90 wide, dark grey, with pale herring-bone pattern dorsally. Epigyne (Figs 13-16): Distinctly protruded, surface of lateral walls adjacent to proscape slightly swollen and lacking spines ("bald swelling"). Proscape thin, long, somewhat narrowing distally. Distal part of scape gradually widening, lateral lobes very small, rounded. Stretcher short and wide. Posterior median plate small, with a notch in distal margin. Receptacles small, rounded. Body coloration and chaetotaxy as in male.

Variability: Dark-colored specimens have a dorsal abdominal pattern composed of pale transverse stripes on a grey background. The shape of the posterior median plate in females is also slightly variable: Fig. 14 cf. Fig. 16.

Taxonomic remarks: This species is similar to *P. khobarum* (Charitonov, 1947) and *P. istrianus* (Kulczyński, 1914), distributed in the Eastern Mediterranean. The male of *P. corfuensis* comb. nov. differs by the much more deeply divided lamella characteristica, and by the bipartite terminal apophysis (vs. fan-shaped). The female of *P. corfuensis* comb. nov. is distinguished by the distinctly longer distal part of the scape, and by the shape of the posterior median plate, namely by the presence of a notch in its distal margin. This notch is absent in the oval posterior median plate of *P. khobarum* and *P. istrianus*.

Distribution: So far this species is known only from the island of Corfu, Greece.

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Genetic and radiographic insights into the only known mounted specimen of Kangaroo Island Emu

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Abstract: The Natural History Museum of Geneva holds a mounted specimen of a dwarf emu, which is believed to be the only preserved skin of the extinct Kangaroo Island Emu, *Dromaius baudinianus*. We obtained new radiographs that show the absence of remaining bones in the preparation, confirming previous statements found in the museum's archives. Moreover, we sequenced the complete mitochondrial genome of this specimen and we compared it to all available emu sequences. The mitogenome of the specimen held in Geneva is very close to that of Common Emus *Dromaius novaehollandiae*. Overall, the genetic results on insular emus support a shallow divergence between the mainland population and the – now extinct – populations from King Island, Kangaroo Island and Tasmania. Based on these results, we agree with previous molecular studies that the insular emu taxa should be treated as three different subspecies of the Common Emu.

Keywords: *Dromaius baudinianus* - Casuariidae - Natural History Museum of Geneva - X-ray - complete mitochondrial genome - ancient DNA.

INTRODUCTION

Emus are iconic ratite birds endemic to Australia. Today a single extant species, known simply as the Emu *Dromaius novaehollandiae* (Latham, 1790), is widely distributed across open habitats, whereas several populations became extinct on islands surrounding mainland Australia: Tasmania, Kangaroo Island and King Island. Each insular population of emu has been recognized as a distinct taxon, mostly because of its distinct small size, at the species or subspecies level. The description of the Kangaroo Island Emu *Dromaius baudinianus* Parker, 1984 was based on bones collected in a cave in 1926 (Parker, 1984). The diagnosis includes differences of the length and shape of the tibiotarsus and tarsometatarsus. The Kangaroo Island Emu is intermediate in size between the smaller King Island Emu *Dromaius minor* Spencer, 1906 [previously *D. ater* Vieillot, 1817, see Dickinson & Remsen (2013)] and the slightly larger Tasmanian Emu *Dromaius diemenensis* Le Souëf, 1907.

Located 110 km southwest of Adelaide, Kangaroo Island is the third largest Australian island after Tasmania and Melville Island. It is separated from the mainland by the 13 km wide Backstairs Passage, which is currently 40 m deep. The island is 145 km long east-west and 54 km long at its widest north-south section, covering 4405 km^2. Its climate is Mediterranean, having mild winters and dry summers. Compared to mainland South Australia, the island has been relatively spared from anthropogenic degradation with almost 40% of the island still being covered by native vegetation (Robinson & Armstrong, 1999). The island's earliest human occupation dates from ca. 16,000 before present (BP; Lampert, 1981). At the beginning of the 18th century, when European expeditions reached the island (see below), evidence suggests that Aboriginal people were not permanently settled on the island but that they used the land occasionally (Draper, 2015). In 1802-1803, a British expedition under Matthew Flinders and a French naval expedition commanded by Nicolas Baudin each sailed close to South Australia. Both expeditions landed on Kangaroo Island to explore and replenish supplies. The French Expedition captured two living emus there on 31st January 1803 (see details in Jansen, 2014, 2018). One died *en route* to Europe and the other was kept captive in Paris until its death

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in 1822. The skeleton of the latter was retained at the Muséum National d'Histoire Naturelle of Paris (MNHN) (registration number MNHN-ZO-AC-A3525), and it was believed that its skin corresponds to the specimen from the Muséum d'histoire naturelle of Geneva (MHNG) (registration number MHNG-OIS-629.041; Fig. 1).

A report from the archives of the Natural History Museum of Geneva from 26th January 1828 states that the mounted specimen was bought in Paris for 150 Swiss francs in December 1827 by M.-E. Moricand, who was then the administrator of the "*Musée Académique de Genève*". Jouanin (1959) found in the registers in Paris that "*a Cassowary from New Holland (without beak)*", of a value of 60 francs, was indeed "given" ("*donné*") to Moricand in December 1827. The specimen was examined by F. de Schaeck (assistant curator at the MHNG), and registered, apparently for the first time, in September 1892 during curatorial activities at the collection. A torn piece of paper, which seemed to read "*Ile Decrès*"(=Kangaroo Island), was then found associated with the specimen. The specimen was exhibited until 1925 and then removed from its socle. It was restored in 1955 and mounted again in February 1958. The specimen, which is still on exhibition in Geneva, was not examined by S. Parker (Parker, 1984). Jouanin (1959) concluded that it was possible that this specimen corresponded to the skeleton preserved in Paris [*contra* Hume (2017) who misinterpreted Jouanin's text], in particular because the measurements of the two specimens matched perfectly. The taxidermists in 1955 indicated that the specimen has no bones at all, and that the bill was artificial. This was confirmed later by a radiography commanded by François Poplin (François Baud in litt.), which was unfortunately not preserved in the archives of the MHNG. Balouet & Jouanin (1990) pointed out that a bone could still remain in one claw of the Geneva specimen, but the evidence for this claim was uncertain. In the same article, Balouet & Jouanin (1990) confirmed the identification of the skeleton in Paris as *D. baudinianus*, according to measurements and bone details found in Parker (1984). They considered that the mounted Geneva specimen was very likely the skin of the mounted Paris skeleton. They also identified as "*D. ater*"= *D. minor* two other specimens; one other mounted specimen held in Paris (MNHN-ZO-2012-610) and another skeleton in Museo di Storia Naturale di Firenze, Italy (C.G.U. 9588; Barbagli & Violani, 2010).

Fig. 1. The Geneva mounted specimen of Kangaroo Island Emu (MHNG–OIS–629.041). Photo P. Wagneur/ MHNG.

Worthy *et al.* (2014) analyzed the skeletal characters of *D. novaehollandiae* and *D. baudinianus* in comparison to an Oligo–Miocene fossil taxon *Emuarius gidju*. They concluded that, apart from their difference in size, the two *Dromaius* taxa did not present major qualitative skeletal differences and that subspecific rank should apply to *D. baudinianus*. Two genetic studies have also been conducted recently on the insular dwarf emus. Heupink *et al.* (2011) investigated the phylogenetic relationships between King Island and mainland emus. They sequenced two partial mitochondrial DNA (mtDNA) regions (Control Region and Cytochrome c oxidase subunit 1) and a small region of a nuclear gene (Melanocortin 1 receptor) for five bone remains from King Island. They found that for these genetic markers King Island emus fall within the diversity of modern samples of mainland emus. Thomson *et al.* (2018) sequenced more samples for mtDNA (Control Region gene only) including ancient bones from the extinct Tasmanian emus (five bones) and Kangaroo Island emus (11 bones). Their conclusions were similar and they suggested that all insular taxa are subspecies of *D. novaehollandiae*.

The first goal of this study was to re-valuate the phylogenetic placement of the specimen held in Geneva relative to all emus previously sequenced, sampled from Kangaroo Island, the other islands, and mainland Australia. To achieve this, we used High-Throughput Sequencing to reconstruct the complete mitochondrial genome for this specimen and compared it to all sequences available for emus. Our second objective was

to shed light on the origin of the Geneva specimen in relation with the skeleton held in Paris Museum. Unfortunately, we were not able to sample this skeleton for genetic analyses. However, the main uncertainty in the chronicle regarding the Geneva specimen is the potential presence of bones within the mount that would disqualify it from being the same individual as the Paris skeleton. Therefore, we obtained new radiographs to test whether bones were left inside the mounted specimen during the taxidermy preparation.

METHODS

DNA Extraction, Library preparation, sequencing, assembly and bioinformatics

DNA was extracted from a toe-pad sample taken from specimen MHNG-OIS-629.041 following the protocol described in Irestedt *et al.* (2006) for historical specimens. Genomic libraries were prepared using the Meyer & Kircher (2010) protocol, with slight modifications as detailed in Johansson *et al.* (2018), and included four unique index libraries to reduce PCR duplicates. All four libraries were pooled together with an additional avian sample (Paradise Parrot *Psephotellus pulcherrimus* – not part of the current study) and sequenced on a single Illumina Hiseq X lane at SciLifeLab Stockholm. Following sequencing, each library was individually processed using a custom designed workflow (available at https://github.com/mozesblom/NGSdata_tools/clean_up_raw_reads.py), which removes adapter contamination, PCR duplicates, merges overlapping read-pairs and excludes low-complexity reads and low-quality bases.

To avoid any putative bias in mitogenome reconstruction, an iterative baiting and mapping strategy was employed to reconstruct the mitogenome for the Geneva specimen. Using a subsample of polished reads (15 million) and the extant emu as a seed reference (Genbank - AF338711), we used MITObim (Hahn *et al.*, 2013) for mitogenome reconstruction and subsequently corrected the resultant sequence by mapping the complete dataset against this initial reference. Each library was mapped using BWA – mem (Li, 2013), the four corresponding BAM files being merged with Picard (https://broadinstitute.github.io/picard/) and variants called using FreeBayes (Garrison & Marth, 2012). Moreover, we masked sites with coverage above or below 3X the mean coverage to avoid the inclusion of putative NUMT calls and low coverage regions. Finally, uncalled sites were manually edited using Geneious R10 (https://www.geneious.com) by lowering the consensus threshold.

Phylogenetic analysis

We compared the complete mitochondrial genome (hereafter DromGE) of the Geneva specimen to the three available complete or near complete mitochondrial genomes of extant continental emus (for clarity hereafter called Common Emu): AF338711 and NC_002784 (both 16,711 bp; origin of the samples unknown) (Haddrath & Baker, 2001), and AY016014 (12,280 bp; captive bird) (Cooper *et al.*, 2001). We also included DromGE to previously published data sets that included both extant and extinct emus for two mitochondrial genes: COI (Heupink *et al.*, 2011) and Control Region (Heupink *et al.*, 2011; Thomson *et al.*, 2018). The COI and Control Region sequences from the complete mitogenomes of Common Emus were added to these data sets.

Divergence time

We used the complete mitogenomes to infer the most recent time of divergence of the Kangaroo Island Emu from the Common Emus. We first applied Lerner *et al.*'s (2011) average rate of sequence divergence of 1.8% per million years for the complete mtDNA genome (0.009 s/s/myr). However it has been suggested that the rates of mitochondrial genes vary among bird species and correlate with life history traits, such as body mass and generation time (Eo & DeWoody, 2010; Nabholz *et al.*, 2009; Pereira & Baker, 2006). The Common Emu is a large and long-lived species, sexual maturity is usually achieved at 2-3 years and longevity is 10-16 years in captivity (Flower, 1938; Del Hoyo *et al.*, 1992). Size varies from 150 to 190 cm, weight from 30 to 55 kg, males being smaller than females (Folch *et al.*, 2018). The life history of the Kangaroo Island Emu is unknown but, although a "dwarf" emu, it was a rather large and probably long-lived bird. We assume that DromGE was a full-grown adult, based on its 19 years in captivity (see introduction). Nabholz *et al.* (2016) suggested that body mass could be used as a proxy to estimate corrected molecular rates for molecular dating studies. We calculated a mass-corrected molecular rate of mitochondrial coding genes following the procedure described in Nabholz *et al.* (2016), using an extrapolated weight for DromGE (23 kg) based on the height of the mounted specimen (116 cm) and on the value for the smallest Common Emus (30 kg for 150 cm). We also used the equation proposed by Nabholz *et al.* (2016) for the mitochondrial coding genes (10,869 bp), based on all codon positions and the two sets of calibrations proposed in this study ("calibrations 2 and 4", see the original article for details).

Radiography

The specimen MHNG-OIS-629.041 was X-rayed using a portable GIERTH TR 90/20 X-ray unit (OR Technology), equipped with a Toshiba tube D-0814/0.8 mm. The unit was connected to a Canon Digital Radiography System CXDI-80C. The images were visualized using a Canon Dicompacs Acquisition Software. Because of its large size, only selected sections of the mounted specimen were examined: the feet, legs, head and back.

RESULTS

Mitogenomes

The complete mitogenome of the Geneva specimen (DromGe, 16,713 bp after final editing) was deposited in GenBank, accession number MK625178. On average DromGE differs from the three Common Emu mitogenomes by 0.090% ± 0.008. Lerner's *et al.* (2011) rate applied to emus suggested that DromGE diverged ca. 100,000 years ago from this set of three Common Emus (mean 93,074 ± 23,029 years). The rates for emus corrected for size, used as a proxy for generation time, varied from 0.004455221 s/s/myr (calibration 2) to 0.007377136 s/s/myr (calibration 4). Applied on the coding genes of the mitochondrial genomes, it suggested that DromGE and the three Common Emus diverged between 206,510 years ago (calibration 2) and 124,716 years ago (calibration 4).

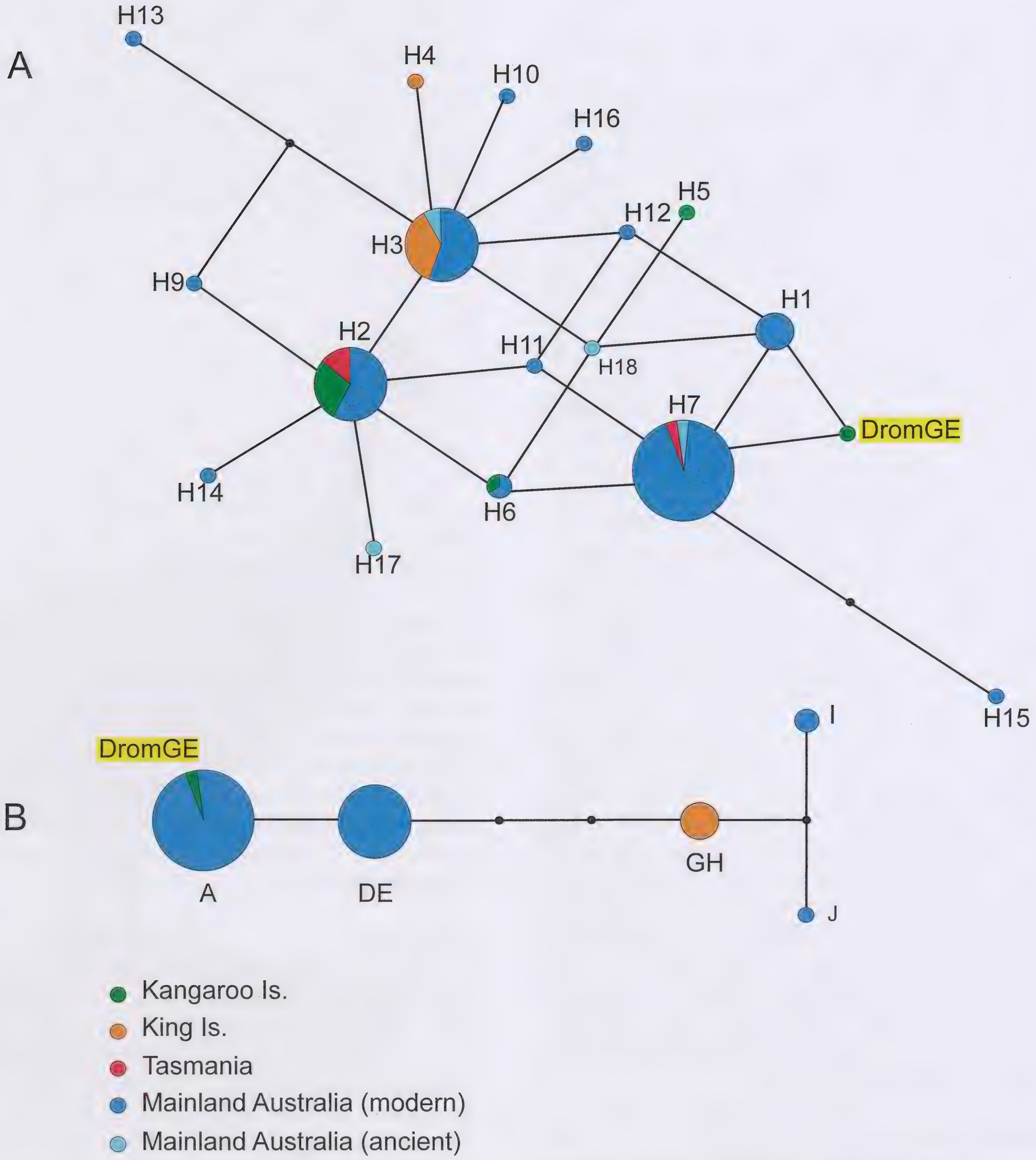

Fig. 2. Haplotype networks. (A) Control Region (563 bp), modified from Thomson *et al.* (2018). (B) COI (1,544 bp), modified from Heupink *et al.* (2011). Circles are proportional to the number of individuals but the scales are different for the two genes (see details in the original studies). The black circles represent intermediate or unsampled haplotypes. "DromGE "indicates the specimen from Geneva Museum.

Control region and COI data sets

We added DromGE's sequence to the genetic haplotype network provided by Thomson *et al.* (2018) for the Control Region (partial gene, 563 bp) (Fig. 2A). This individual has a new haplotype, different by one substitution to haplotypes H7 (predominantly found in Common Emus) and H1 (Common Emus, including AF338711 and NC_002784; AY016014 was not sequenced for this gene). It differs by two to three substitutions to the three haplotypes found in bones from Kangaroo Island: H6, also found in mainland samples; H2, found also in mainland and Tasmanian samples; and H5, found in a single Kangaroo Island bone.

Regarding the COI gene (Fig. 2B), DromGE shares Haplotype A with Common Emus. It differs by two mutations from the haplotype GH found in King Island Emus. Bones from Kangaroo Island Emus were not sequenced for this gene. Common Emus also share three other haplotypes, DE (including AF338711, NC_002784 and AY016014), I and J.

Radiography

Images were taken at different sections of the specimen: all showed that no bones were conserved in the preparation, in particular in the toes (Fig. 3). No elements of the skull were conserved either, and the bill is artificial and supported by wires.

DISCUSSION

The origin of the Geneva specimen

The genetic data do not provide definitive elements regarding the origin of the Geneva specimen, DromGE. Because no unique haplotypes exist for Kangaroo Island or King Island populations, the putative geographic origin of Kangaroo Island for this specimen can be neither confirmed nor refuted. The new radiographs show the absence of remaining bones in the preparation, confirming previous statements found in the museum's archives. Balouet & Jouanin's (1990) claim of a remaining bone in a toe of the Geneva specimen might have been based on the fact that a bone was missing from the Paris skeleton (left foot, digit II, proximal phalanx; A. Cibois pers. obs.). It is common practice to keep the bones in the legs and feet of birds, even in large birds such as ratites (Davie, 1894; Larsen, 1945). However, skin and skeleton for an individual large bird could also have been sold separately, resulting in boneless mounted specimens. For instance, we checked the foot of another old mounted specimen in Geneva (a Common Emu acquired in 1926; MHNG 837.071) and no bones were preserved in that one either. Thus, the lack of bones in the Geneva specimen is not absolute proof that it is the same individual as the Paris skeleton. Nonetheless, we conclude that after considering the historical evidence and correspondence of the measurements of both specimens, the hypothesis of Kangaroo Island provenance for DromGE remains the most likely.

Divergence time and isolation of the Kangaroo Island Emu

Previous studies on the extinct emus showed that the island populations had a subset of the mitochondrial genetic diversity found in Common Emus. The numbers of extant emus on mainland Australia have increased ca. tenfold since colonization by Europeans, with some fluctuation in numbers, as they benefited from increased water supplies and the erection of fences to exclude predators like dingos (*Canis lupus dingo*) (Folch *et al.*, 2018; Pople *et al.*, 2000). Their numbers are currently considered as stable, and no recent bottleneck has led to the erosion of genetic diversity. The mitogenome of the specimen held in Geneva is very weakly divergent from that of Common Emus. Taken together, all the mitochondrial results on island populations of emus support a shallow divergence between the extant mainland population and the extinct populations from King Island, Kangaroo Island and Tasmania. An alternative explanation could be that these results are biased by introgression events that led to the capture of the mainland mitogenome (the most important population in number) by that of the three island populations. However, the topology of the largest haplotype network (for the Control Region, Fig. 2A) based on 134 individuals, is consistent with incomplete lineage sorting, the island taxa having both shared and unique haplotypes. Based on these results, we agree with Heupink *et al.* (2011) that all emu taxa should be considered as subspecies of *Dromaius novaehollandiae*, *D. n. diemenensis* (Tasmania), *D. n. minor* (King Island) and *D. n. baudinianus* (Kangaroo Island).

Heupink *et al.* (2011) and Thomson *et al.* (2018) discussed the morphological differences between the insular dwarf populations and the mainland emus. They based their analyses on the hypothesis of a very recent isolation of these islands during the Holocene, when sea-level rose after the Last Glacial Maximum and flooded the straits connecting the islands: 10,000 years ago for Kangaroo Island and the mainland, 12,000 years ago for King Island and Tasmania, and 14,000 years ago for Tasmania and the mainland (Lambeck *et al.*, 2014). These short time frames would imply that the significant reduction of size occurred very rapidly for such long-lived birds. Our divergence time analysis, although based on a single insular individual and on Common Emus of unknown origin, suggests on the other hand that the isolation of the emus of Kangaroo Island, or some population structure on nearby parts of mainland Australia, took place during the Pleistocene, at least ca. 100,000 years ago. Probably the most parsimonious scenario implies the mid-Pleistocene episodes of sea-level variations that could have triggered the isolation of emus on Kangaroo Island. During the glacial Marine Isotope Stage 6 (which began 190,000 years ago), sea-level dropped ca. 100 m below present sea level, permitting a land connection

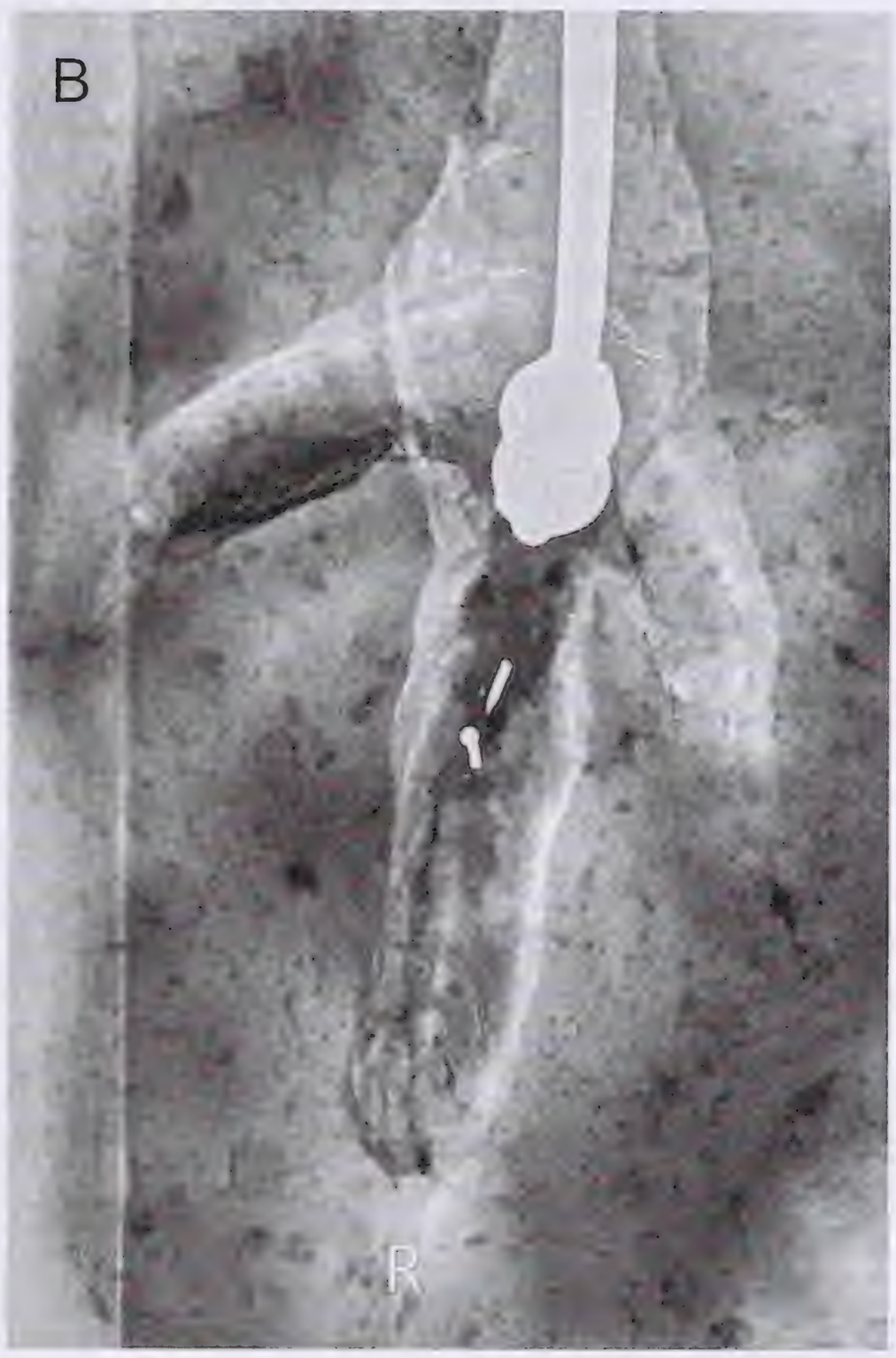

Fig. 3. Radiographs of the specimen MHNG-OIS-629.041. (A) Left foot. (B) Right foot. (C) Head and neck. (D) Back. (E) Thighs and upper legs.

between Kangaroo Island and Australia (Elderfield *et al.*, 2012). During the Last Interglacial Maximum (Marine Isotope Stage 5e, which began 130,000 years ago and ended about 115,000), sea level was up to 6 m or 9 m above present sea surface in the Pacific Ocean (Dickinson, 2001; Hearty *et al.*, 2007), inundating the 40 m deep Backstairs Passage between Kangaroo Island and Australia and leading to the isolation of the former's emu population. This period resulted in the inundation of many land surfaces in the Pacific Ocean, and in particular on low atolls, leading for instance to the extirpation of landbird populations in the Eastern Pacific (Cibois *et al.*, 2010). Our new estimation of the divergence time for the Kangaroo Island Emu, based on a molecular clock, suggests then that the morphological differentiation (i.e. dwarfing) of this insular population, due to selection or genetic drift, took place over a longer period of time than proposed by previous studies.

Kangaroo Island, a biodiversity refugium in past and recent times

Kangaroo Island is one of the six major biodiversity hotspots identified across the state of South Australia for plants (Guerin *et al.*, 2016), with 45 endemic species being inventoried by Kinnear *et al.* (1999). The island also includes three recently described species: two lichens (Kantvilas & Kondratyuk, 2013) and one fungus (Catcheside *et al.*, 2015). Along with other parts of southern Australia, Kangaroo Island is thought to have acted as a refugium for Mediterranean and semi-arid plants during colder and drier periods (Byrne, 2008). However, such a high level of endemism has not been found for animals. The only endemic mammal, the Kangaroo Island Dunnart (*Sminthopsis aitkeni*), presents shallow morphological and genetic differentiation from closely related mainland taxa and it has recently been reclassified as a subspecies of the Sooty Dunnart (*Sminthopsis fuliginosus*) by Kemper *et al.* (2012). The situation is similar for birds, in which the only endemic species, the Kangaroo Island Emu, has been reevaluated as warranting only subspecific rank based on its shallow genetic difference from mainland populations (Thomson *et al.*, 2018; this study). In fact, the majority of organisms for which genetic studies have been conducted show a weak differentiation between Kangaroo Island and mainland Australia: Western Grey Kangaroos (*Macropus fuliginosus*) (Neaves *et al.*, 2009), Tawny Dragon Lizard (*Ctenophorus decresii*) (McLean *et al.*, 2014), *Labiosimplex australis* (a parasitic nematode) (Chilton *et al.*, 2009), Narrow-leaf Hopbush (*Dodonaea viscosa angustissima*) (Christmas *et al.*, 2017). A more complex genetic pattern was found in the Crimson Rosella complex (*Platycercus elegans*), in which the subspecies endemic to Kangaroo Island showed introgression from nearby mainland populations (Joseph *et al.*, 2008). 17 subspecies of birds are endemic to Kangaroo Island (Schodde & Mason, 1999) but most of them have not been subjected to molecular analyses.

Because some pristine habitats are still present on Kangaroo Island, the island acted as a recent refugium for species endangered or extirpated from mainland Australia. For instance, the last population of an endangered subspecies of the Glossy Black-Cockatoo (*Calyptorhynchus lathami halmaturinus*) is now restricted to Kangaroo Island. The diet of this bird is specialized to the seeds of sheoaks (*Allocasuarina verticillata*). Extensive tracts of this tree and the bird have both disappeared from nearby parts of mainland Australia, the bird last having been recorded in the late 1970s (Joseph, 1989; Berris *et al.*, 2018; Schodde *et al.*, 1993). Species on Kangaroo Island have also been preserved from alien predators or competitors that have not reached the island. It is the case for the Bush Rat (*Rattus fuscipes greyii*), which populations on Kangaroo Island present higher genetic diversity than those on the mainland (Hinten *et al.*, 2003).

The entomofauna of Kangaroo Island is poorly known, but a recent discovery brought to light an endemic moth species. This new species, called the "enigma moth", exhibits a unique combination of morphological characters and it was placed in a new family Aenigmatineidae (Kristensen *et al.*, 2015). A molecular analysis showed that it was basal in the phylogenetic tree of the moth families, suggesting an old origin. The current restricted distribution of such an ancient family suggests that the Kangaroo Island moth could be either a paleo-endemic that had a wider distribution in the past and disappeared from most of its range due to climate modifications – or a pseudo-endemic (i.e. a species with a large distribution anthropogenically reduced by habitat loss). These alternative hypotheses, which might also apply to several endemic plants, both support the idea that Kangaroo Island acted more as a museum than as a cradle for biodiversity [*sensu* Stebbins (1974)]. Most of its diversity did not evolve *in situ*, but the island, by its ancient and recent history, has been a refugium for many plants and animals.

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Occurrence of *Dibothriocephalus latus* in European perch from Alpine lakes, an important focus of diphyllobothriosis in Europe

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Abstract: The broad fish tapeworm *Dibothriocephalus latus* (syn. *Diphyllobothrium latum*) is one of the most common causative agents of human diphyllobothriosis, a significant fish-borne parasitic zoonosis. In Europe, the occurrence of *D. latus* has been repeatedly reported in lakes of the Alps region, the Baltic region, Fennoscandia and Russia. Regular detection of *D. latus* plerocercoids in fish coming from different subalpine lakes linked with ongoing *D. latus* infection in humans indicates that Alpine region is a rather specific area from the medical, epidemiological and ecological point of view. Results from the examination of 688 European perch (*Perca fluviatilis*) from six subalpine lakes in Switzerland, France and northern Italy (Lakes Geneva, Neuchâtel, Biel, Como, Maggiore and Iseo) confirmed the ongoing occurrence of *D. latus* in the Alps region. The detected prevalence of *D. latus* in the studied Alpine lakes (2% in Lake Neuchâtel; 37.5% in Lake Biel; 6.4% in Lake Geneva; 22.8% in Lake Iseo [2018]; 12.8% in Lake Iseo [2017]; 15.2% in Lake Como; 16.7% in Lake Maggiore) was compared with previously published data. In addition, the importance of the Alpine lakes region and data on the epidemiology and ecology of *D. latus* related to subalpine lakes were discussed.

Keywords: Diphyllobothriosis - fish-borne zoonosis - plerocercoid - European perch - *Perca fluviatilis* - prevalence, genotyping.

INTRODUCTION

Studies on the geographic distribution of parasitic species are fundamental for understanding their circulation in the natural environment and for an assessment of endemic regions. In the case of parasites with zoonotic potential, knowledge on the distribution of a particular species is furthermore important for determining the potential risk for humans. Food-borne transmission of causative agents of parasitic zoonoses is considered to be one of the most frequent paths of infection. A special category of food-borne diseases are fish-borne parasitic zoonoses, characterized by their transmission via freshwater, brackish or marine fish.

Diphyllobothriosis, caused by so-called "broad tapeworms" or "fish tapeworms" of different genera of the order Diphyllobothriidea, is a significant fish-borne parasitic zoonosis responsible for about 20 million human infections worldwide (Chai *et al*., 2005). One of the most common causative agents of human diphyllobothriosis is the broad fish tapeworm *Dibothriocephalus latus* (Linnaeus, 1758) (Cestoda: Diphyllobothriidea), previously known under the scientific name *Diphyllobothrium latum*. Recent phylogenetic study of the order Diphyllobothriidea divided the polyphyletic genus *Diphyllobothrium* into two, *Diphyllobothrium* and the resurrected *Dibothriocephalus* (Waeschenbach *et al*., 2017) comprising seven species with *D. latus* as the type species.

The complex life cycle of this tapeworm involves two intermediate hosts (crustaceans and fish) and a definitive host (fish-eating mammals, including humans). Humans, probably the main definitive host maintaining the life cycle of the parasite (Golay & Mariaux, 1995), can be infected by the consumption of raw or undercooked fish fillets containing infective larval stages, plerocercoids. Diphyllobothriosis has been associated with eating habits, such as the consumption of salted or marinated fish fillets

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in the Baltic or Scandinavian countries and local raw fish specialities in the Alpine region (Switzerland, France and northern Italy), which represents the area with frequent or relatively frequent occurrence of diphyllobothriosis in humans (Golay & Mariaux, 1995; Desvois *et al.*, 2001; Peduzzi & Boucher-Rodoni, 2001; Terramocci *et al.*, 2001; Dupouy-Camet & Peduzzi, 2004; Yera *et al.*, 2008; Wicht *et al.*, 2010a, b). Infections in humans can be either autochthonous, or *D. latus* can be acquired during trips or stays abroad (imported cases). On the other hand, the direct detection of plerocercoids in the second intermediate fish host reflects the occurrence of the parasite in a particular natural environment. In Europe, the European perch (*Perca fluviatilis*) is the most suitable host of *D. latus*, while the Northern pike (*Esox lucius*) serves as a common paratenic host, and the burbot (*Lota lota*) plays a less important role in transmitting *D. latus* to humans (Gustinelli *et al.*, 2016). The occurrence of *D. latus* in fish has been frequently detected in lakes of the Alpine region, including northern Italy (Gustinelli *et al.*, 2016), Switzerland and France (Dupouy-Camet *et al.*, 2015). Moreover, regular detection of *D. latus* plerocercoids in fish was also confirmed in Russia (Klebanowski, 1985; Novak, 2012; Dugarov & Pronin, 2017), the Baltic region, in particular Estonia (Jõgiste & Barotov, 1993; Wicht *et al.*, 2010a, b), and Fennoscandia, including Finland (Andersen & Valtonen, 1992; Valtonen & Julkunen, 1995; Valtonen *et al.*, 1997), Norway (Vik, 1957) and Sweden (Akuffo *et al.*, 2003).

The Alpine region represents an important area from a medical and epidemiological point of view due to local eating habits and the relatively frequent detection of *D. latus* infection in humans. The rather constant prevalence and regular detection of *D. latus* plerocercoids in fish also make this region very interesting from an ecological point of view. The aim of this study was to provide the latest data on the occurrence of *D. latus* plerocercoids in European perch from different Alpine lakes to reveal the current situation of *D. latus* occurrence and to compare it with previously published data.

MATERIAL AND METHODS

A total of 688 European perch (*Perca fluviatilis*) originating from six Alpine lakes (Fig. 1) were examined for *D. latus* plerocercoids. Out of them, 156 fish originated from Lake Geneva (Switzerland/France), 50 from Lake Neuchâtel (Switzerland), 8 from Lake Biel (Switzerland), 46 from Lake Como (Italy), 48 from Lake Maggiore (Italy/Switzerland) and 380 from Lake Iseo (Italy). The examinations were carried out in March 2017 (Lakes Como, Maggiore and Iseo), May 2018 (Lake Iseo) and June 2018 (Lakes Geneva, Neuchâtel and Biel). The fish were caught by professional fishermen using gill nets and kept on ice until they were dissected. Fish were examined by parasitological necropsy focused on musculature and the peritoneal cavity (intestine, liver and other abdominal organs). In order to detect the presence of *D. latus* larvae in muscles, thin (approximately 5 mm) slices of fillets of whole fish were carefully examined by direct observation. The parasites found in host tissues were isolated by means of dissecting needles, checked under a stereomicroscope, placed in 0.9% NaCl solution and finally fixed in 96% molecular-grade ethanol for further molecular analyses.

For molecular genotyping of plerocercoids, genomic DNA of all individuals was isolated using the QIAamp®

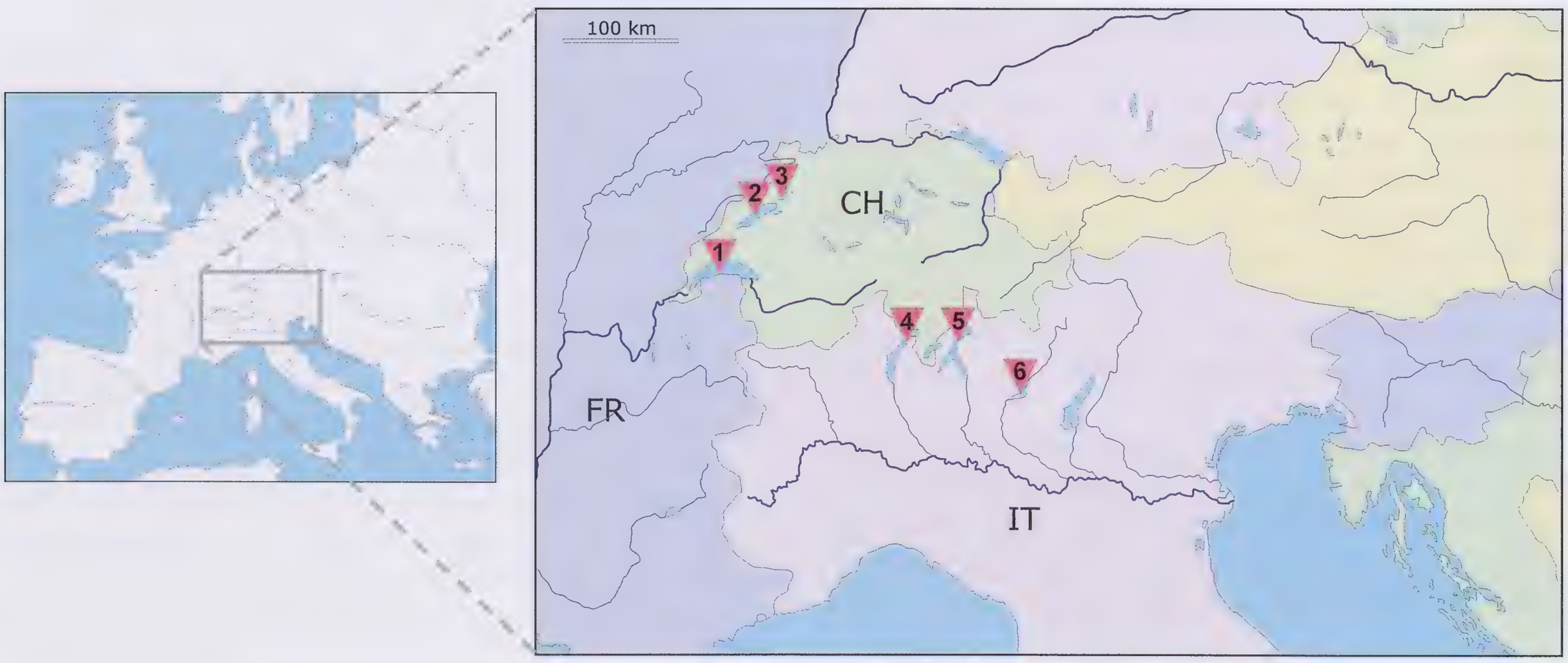

Fig. 1. Schematic representation of sampling sites of *Dibothriocephalus latus* from European perch (*Perca fluviatilis*) from the Alpine lakes region. (1) Lake Geneva; (2) Lake Neuchâtel; (3) Lake Biel; (4) Lake Maggiore; (5) Lake Como; (6) Lake Iseo. FR, France; CH, Switzerland; IT, Italy. Maps obtained from d-maps.com.

DNA Mini Kit (QIAGEN, Hilden, Germany) following the instructions of the manufacturer. *D. latus*-specific PCR was performed with the forward MulLat3 (GGGGTGTTACGGGTATTATACTC) and reverse MulRevCom (ATGATAAGGGAYAGGRGCYCA) primers designed for amplification of a partial (437 bp) fragment of mitochondrial cytochrome *c* oxidase subunit 1 (*cox*1 mt DNA), according to Wicht *et al.* (2010b). The PCR products were visualized on 1.5% agarose gel and purified using exonuclease I and shrimp alkaline phosphatase (Werle *et al.*, 1994). Sequencing was performed using the automatic genetic analyzer Applied Biosystems 3130xl (Applied Biosystems, Foster City, California, USA) and the BigDye Terminator v3.1 Cycle sequencing kit (Applied Biosystems). Contiguous sequences were assembled and inspected for errors using Geneious (version 10.0.5, Biomatters, Auckland, New Zealand). The newly obtained *cox*1 sequences were compared with respective sequences of *D. latus* available in the GenBank (https://www.ncbi.nlm.nih.gov/genbank/).

RESULTS

Table 1 summarizes data on the fish examined and the prevalence detected in each particular lake. The lowest prevalence (2%) was detected in Lake Neuchâtel. The highest prevalence (37.5%) was observed in Lake Biel; however, this could be influenced by the rather low number (no = 8) of fish examined. As for the other four lakes, the prevalence varied from 6.4% (Lake Geneva) up to 22.8% (Lake Iseo; 2018). The prevalence was mostly in the range of 10-20%, in particular 12.8% (Lake Iseo; 2017), 15.2% (Lake Como) and 16.7% (Lake Maggiore). Each fish was mainly infected by a single plerocercoid in the musculature, predominantly in dorsal muscles. In Lake Geneva, three fish were infected with two larvae and one perch harboured five plerocercoids.

Altogether, 108 plerocercoids were obtained from 688 European perch from the six studied Alpine lakes; all of them were subjected to molecular genotyping. Sequences of a 430 bp mitochondrial *cox*1 fragment of all individuals were 100% identical, and no intraspecific genetic diversity was observed. Comparison of the newly obtained data with the sequences deposited in the GenBank revealed 100% identity with *D. latus* from European perch from Switzerland (GenBank Accession numbers FM209180-1, GU997614, AY972071, DQ768197) and Italy (GU997613, KU341699, KU341702, KU341709, KU341711-2, KU341716), as well as with *D. latus* from Northern pike (KU341707 and KU341714) and burbot (KU341705) from Italy.

DISCUSSION

Current data on the occurrence of *D. latus* in perch from Lakes Como, Iseo, Maggiore, Geneva, Biel and Neuchâtel confirmed the presence of this medically important causative agent of diphyllobothriosis in the Alpine region, corresponding well to previously published results (Bouvier *et al.*, 1963; Golay & Mariaux, 1995; Peduzzi & Boucher-Rodoni, 2001; Dupouy-Camet & Peduzzi, 2004; Nicolaud *et al.*, 2005; Wicht *et al.*, 2009a, b; Prearo *et al.*, 2013; Dupouy-Camet & Yera, 2015; Dupouy-Camet *et al.*, 2015; Gustinelli *et al.*, 2016). These surveys were predominantly focused on examinations of European perch, the most suitable host of *D. latus* (Table 1). Hence, the data provided in the current paper were based only on examinations of perch, and no other fish species were investigated.

As has been observed previously, the majority of plerocercoids collected from perch were found in fillets, while only a few of them were collected from the serosa (Gustinelli *et al.*, 2016). The location of plerocercoids in the visceral cavity also depends on the size of the perch. According to the personal experience of one co-author (A. Gustinelli), perch of larger size can ingest smaller infected perch, thus becoming a paratenic host, similarly to burbot and pike. In the current study, all plerocercoids were found in perch fillets; no larvae were detected in the peritoneal cavity or internal organs. The length of the perch examined ranged between 100-300 mm; however, most of the fish were around 150 mm in length, which may explain the absence of plerocercoids in the serosa.

Most studies on *D. latus* prevalence in fish have focused on Lake Geneva, shared between Switzerland and France, where the prevalence of *D. latus* in perch ranged between 4.0-29.2% (Dupouy-Camet & Peduzzi, 2004; Nicolaud *et al.*, 2005; Wicht *et al.*, 2009b; Dupouy-Camet & Yera, 2015; Dupouy-Camet *et al.*, 2015). In contrast, the oldest data on the prevalence of *D. latus* in fish in Lake Geneva provided significantly higher values, in particular 95% in burbot and 58% in perch (Ketchekian, 1909 cited in Bouvier *et al.*, 1963). These findings indicated the specific dynamics of the occurrence of *D. latus* in the Alpine region. Diphyllobothriosis caused by *D. latus* was a widespread fish-borne zoonosis at the beginning of the past century; however, it virtually disappeared later on (Gustinelli *et al.*, 2016). Since the early 1980s, especially after year 2000, diphyllobothriosis has shown a comeback in some subalpine areas, particularly on the shores of the great subalpine lakes (Wicht *et al.*, 2009a, b).

Currently, the detected prevalence of *D. latus* in perch from Lake Geneva was 6.4%, which fits into the most frequent and previously published values (4.0-12.0%) (Table 1). A rather high prevalence (22.2-28.6%) has been detected in burbot, and even a 100% prevalence was documented in pike (Dupouy-Camet & Yera, 2015; Dupouy-Camet *et al.*, 2015). In general, pike seems to be the host with the highest detected prevalence of *D. latus*, with 12.5% in Lake Morat and 14.3% in Lake Biel, up to very high values of 71.4% (Lake Iseo), 84.2% (Lake Como) and 100% in Lakes Maggiore and Geneva (see Table 1 for references).

In the current study, the detected prevalence of *D. latus*

Table 1. Summary of literature data and current results of prevalence of *Dibothriocephalus latus* plerocercoids in European perch (*Perca fluviatilis*), pike (*Esox lucius*) and burbot (*Lota lota*) from the Alpine lakes in Italy (Lakes Como and Iseo), Italy/Switzerland (Lake Maggiore), Switzerland/France (Lake Geneva) and Switzerland (Lakes Biel, Morat and Neuchâtel).

Country	Locality	Host	No. of fish/ fillets examined	Prevalence (%)	Reference
Italy	Lake Como	European perch	609	30.0	Wicht *et al.*, 2009a
			390*	28.7	Prearo *et al.*, 2013
			426	25.4	Gustinelli *et al.*, 2016
			46	15.2	current study
		Pike	19	84.2	Gustinelli *et al.*, 2016
		Burbot	55	3.6	Gustinelli *et al.*, 2016
	Lake Iseo	European perch	458	7.6	Gustinelli *et al.*, 2016
			148	12.8	current study (2017 sampling)
			232	22.8	current study (2018 sampling)
		Pike	7	71.4	Gustinelli *et al.*, 2016
		Burbot	26	3.8	Gustinelli *et al.*, 2016
Italy/Switzerland	Lake Maggiore	European perch	309	7.8	Peduzzi & Boucher-Rodoni, 2001
			880**	14.0	Wicht *et al.*, 2009b
			635	6.6	Gustinelli *et al.*, 2016
			48	16.7	current study
		Pike	1	100	Gustinelli *et al.*, 2016
Switzerland/France	Lake Geneva	European perch	50*	8.0	Dupouy-Camet & Peduzzi, 2004
			50*	12.0	Dupouy-Camet & Peduzzi, 2004
			50*	4.0	Nicolaud *et al.*, 2005
			50*	6.0	Nicolaud *et al.*, 2005
			50*	8.0	Nicolaud *et al.*, 2005
			50*	10.0	Nicolaud *et al.*, 2005
			532**	5.1	Wicht *et al.*, 2009b
			24*	29.2	Dupouy-Camet *et al.*, 2015
			25*	28.0	Dupouy-Camet & Yera, 2015
			156	6.4	current study
		Pike	160	12.5	Bouvier *et al.*, 1963
			6*	100	Dupouy-Camet *et al.*, 2015
			7*	100	Dupouy-Camet & Yera, 2015
		Burbot	7*	28.6	Dupouy-Camet *et al.*, 2015
			9*	22.2	Dupouy-Camet & Yera, 2015
Switzerland	Lake Biel	European perch	81	3.7	Golay & Mariaux, 1995
			8	37.5	current study
		Pike	7	14.3	Golay & Mariaux, 1995
	Lake Morat	European perch	19	5.3	Golay & Mariaux, 1995
		Pike	8	12.5	Golay & Mariaux, 1995
	Lake Neuchâtel	European perch	50	2.0	current study
		Pike	26	11.5	Bouvier *et al.*, 1963

* indicates examination of European perch fillets; ** either whole fish or fish fillets were investigated depending on the type of samples provided by the fishermen.

in perch from Lake Como was the lowest (15.2%) when compared with previously reported data (Table 1). In three other lakes (Iseo, Maggiore and Biel), the prevalence in perch revealed the highest values in comparison with previous data (Table 1). Since only eight fish were currently examined in Lake Biel, and a different sample size of examined fish was analysed in the present work and previously published surveys, it is difficult to compare data on prevalence and make reliable conclusions.

Besides the Alpine lakes, the presence of *D. latus* has also been confirmed in fish in Russia, the Baltic region, and Fennoscandia (see the above references in the Introduction). However, diphyllobothriosis seems to be strongly reduced or even to have disappeared in many of these localities (Scholz & Kuchta, 2016), which may have several explanations. In the past, *D. latus* occurred in a particular locality, but due to some environmental/ biological changes preventing the maintenance of the parasite life cycle, it has disappeared from the region. Another explanation for the lack of data on *D. latus* occurrence in previously endemic areas, such as the Baltic region and Fennoscandia, are altered eating habits of humans, resulting in a decrease of diphyllobothriosis to the point that it is no longer a serious medical problem. As a consequence, physicians and parasitologists can pay lower attention to this parasitosis.

In the subalpine territory, humans seem to be the most suitable host of *D. latus* (Wicht *et al.*, 2009b) and probably serve as the only definitive host maintaining the life cycle of the parasite (Golay & Mariaux, 1995). Wild or domesticated carnivores may play only a minor role in the continuation of the cycle (Dupouy-Camet & Peduzzi, 2004). Although knowledge on the ecology and epidemiology of helminths shared by wild carnivores in Europe is limited, wild felids can contribute to environmental contamination and maintenance of the life cycle of *D. latus* (Otranto *et al.*, 2015; Zottler *et al.*, 2019). However, the latest examination of 168 stray cats in different regions in Switzerland revealed the presence of *D. latus* eggs only in one faecal sample (Zottler *et al.*, 2019).

The presence of *D. latus* in perch in Alpine lakes is of great importance from a public health perspective, as the increasing popularity of raw fish dishes is thought to be linked to the re-emergence of human diphyllobothriosis in the subalpine area (Wicht *et al.*, 2009b). Plerocercoids may survive in perch from several months up to a few years (Dick *et al.*, 2001; Dick, 2007), and since they mainly prefer dorsal muscles (Prearo *et al.*, 2013), they can be easily missed during food preparation (Jackson *et al.*, 2007). Therefore, it is not surprising that human diphyllobothriosis in the Alpine lakes has corresponded to the infection of perch with *D. latus* plerocercoids (Wicht *et al.*, 2007), and the subalpine area has been the site of several episodes of human infections (Gustinelli *et al.*, 2016). Ineffective sewage treatment systems, which lead to the contamination of lakes by cestode eggs shed by infected humans, is the second main risk factor for the persistence of diphyllobothriosis in subalpine lakes (Gustinelli *et al.*, 2016). In addition, faecal pollution of lakes by professional and leisure fishing on and around lakes can also be considered as one of the important factors in the continuation of the life cycle (Dupouy-Camet & Peduzzi, 2004). Therefore, preventive measures, sanitary precautions and healthcare education concerning safe raw fish preparation have been permanently important and should also continue in future.

Ongoing epidemiological and ecological monitoring of diphyllobothriosis in the Alpine region has provided the latest data and dynamics on the occurrence of this fish-borne zoonosis. As for other European regions, up-to-date surveys are necessary for accurate knowledge on human diphyllobothriosis and the circulation of *D. latus* in the natural environment. Special attention should be paid to localities with previous findings of the tapeworm based only on morphology. Modern differentiation techniques and the latest knowledge on ecology and distribution of *D. latus* should be applied in future studies on this medically important and biologically interesting tapeworm.

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A preliminary study of the blister beetles fauna from Niger based on the collections of the Geneva and Paris museums (Coleoptera, Meloidae)

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Abstract: The blister beetles fauna from Niger is studied and 22 species are recorded in this paper, 13 for the first time, for a total of 31 species recorded from this country. One species, *Hycleus adrarensis* (Pic, 1942), is resurrected from its synonymy, and *Hycleus kaszabi* (Pardo Alcaide, 1968) is regarded as conspecific with *Hycleus adrarensis*.

Keywords: Meloidae - Niger - Sahel - distribution.

INTRODUCTION

The blister beetles of Niger were so far not well known and the present report provides new occurrence data on these animals based on specimens in museum collections and also the private collection of the author.

During a visit to the Muséum d'Histoire Naturelle de Genève, twelve different species of Meloidae originating from Niger were identified. Formerly the blister beetle fauna of this country was very poorly known. These specimens were mostly obtained by two collectors H. Guèvremont and H.E. Martin in the early 1980s. Hélène Guèvremont is a canadian entomologist who worked numerous years in Niger at the Centre National de Recherches Agronomiques de Tama (CNRAT) at Maradi, where she principally studied the insect pests of the millet, so we can suppose that she mainly collected the specimens on this cultivated plant.

Additionnally Pierre Juhel, a French specialist of the African Callichromatini (Cerambycidae) sent to me his samples from Niger for study.

Material from the "Mission Tilho" was also examined for this study. It was a geographic expedition led by army captain J. Tilho to demarcate the border between the French and English colonies in the region of Niger River and Lake Chad (Zimmermann, 1909). The physician of the expedition, Dr R. Gaillard, was in charge of collecting specimens for scientific study and all these specimens are now stored in the Muséum National d'Histoire Naturelle of Paris.

MATERIAL AND METHODS

Gazetteer: The map in Figure 1 shows: (a) the different localities where the collectors from MHNG and MNHN sampled the specimens; (b) those where Pierre Juhel got his specimens (only Kouré); (c) and the Aïr Mountains, the only previously well-studied area in Niger. The white area in the middle represents the Sahelian Acacia Savanna; the southern ecozone represents the West Sudanian Savanna; the further Northern ecozone is the Sahara, which has scarcely been sampled. There is an additional ecozone in the south-east of Niger, represented by the Lake Chad flooded savanna.

Abbreviations: The acronyms used in the texts are the followings:

MFC: Mickaël François, private Collection
MHNG: Muséum d'Histoire Naturelle de Genève (Genève, Suisse)
MNHN: Muséum National d'Histoire Naturelle (Paris, France)

RESULTS

Lydomorphus (L.) angusticollis angusticollis (Haag-Rutenberg, 1880)

Specimens studied: MNHN; 9 specimens; Agadez Region, Aïr Mountains, 20 km E of Agadez; collected 1908; les Posth. – MFC; 5 specimens; Tillaberi Region, Kouré; collected Sept. 2002; leg P. Juhel.

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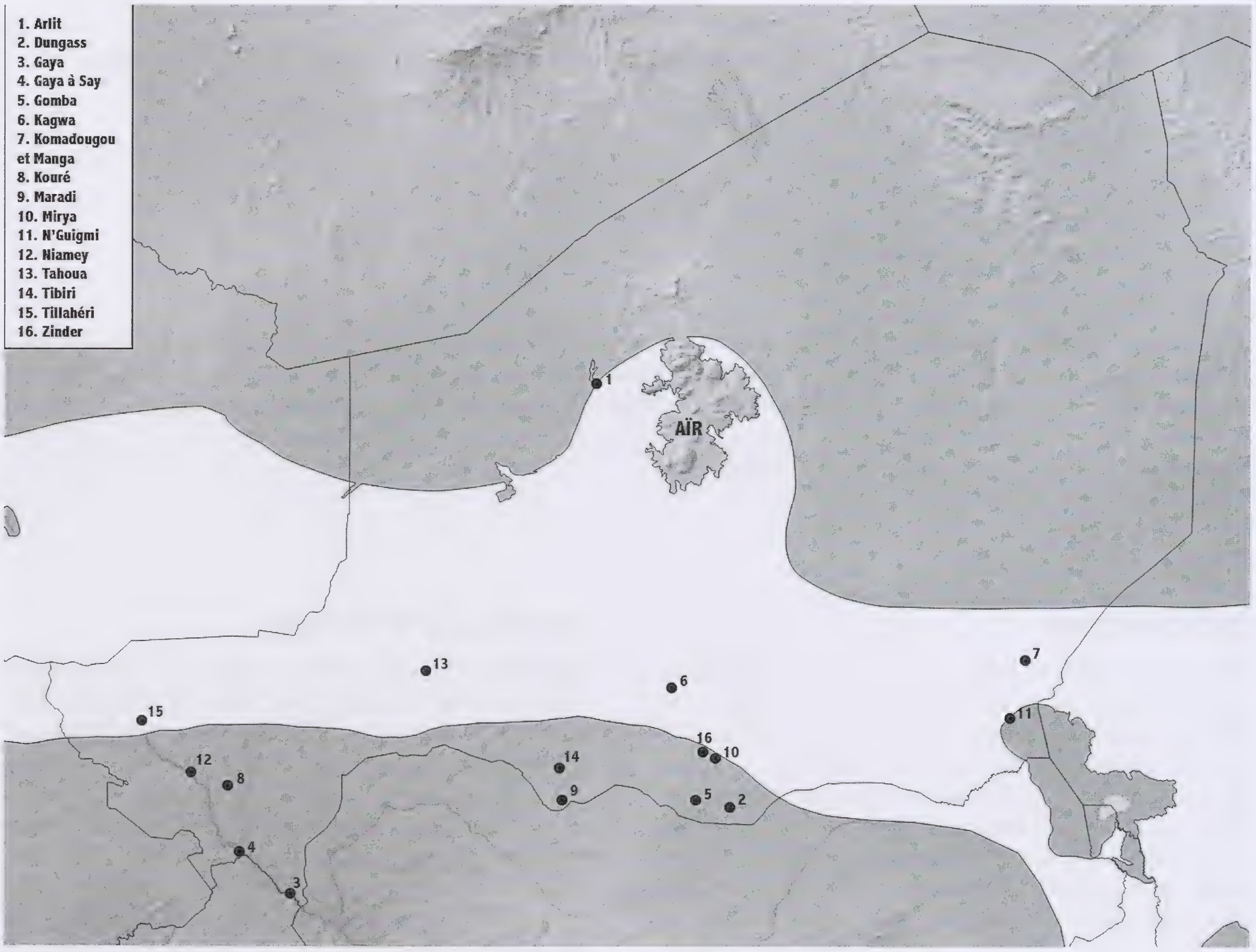

Fig. 1. Locations of the samplings sites mentioned in the text.

Bibliographic data for Niger: Agadez, Kori Atkakit (Pic, 1950).

Geographic distribution: Chad, Eritrea, Ethiopia, W India, S Iran, Mauritania, Niger, Nigeria, Pakistan, Saudi Arabia, Somalia, Sudan, Yemen (Bologna, 1990).

Remark: This species has a wide and characteristic distribution, since it occupies three biogeographic regions Afrotropical, Palaearctic and Oriental, making this species of Meloidae unique in term of distribution.

Lydomorphus (L.) pilitarsis (Kaszab, 1955)

Specimens studied: MNHN; 17 specimens; Zinder Region, Dungass; collected Sept.-Oct. 2010; leg R. Gaillard, Mission Tilho.

Geographic distribution: Benin, Gambia, Mauritania, Niger, Senegal (Selander, 1988a).

Remark: This species was described by Kaszab (1955) in his revision of the genus and the specimens in the collection are often misidentified with *L. melanocephalus* (Fabricius, 1801). It seems to be restricted to the western part of the Sahelian area.

Lydomorphus (Pardolydus) dusaulti (Dufour, 1821)

Specimens studied: MFC; 8 specimens; Tillaberi Region, Kouré; collected Sept. 2002; leg P. Juhel.

Geographic distribution: Burkina Faso, Chad, D.R. Congo, Eritrea, Ethiopia, Ghana, Guinea-Bissau, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan (Bologna, 1990).

Remark: A very common species, but unexpectedly, it is the first citation for Niger.

Cyaneolytta maculifrons (Mäklin, 1875)

Specimens studied: MNHN; 1 specimen; Zinder Region, Zinder; collected 21.07.1947; leg L. Chopard & A. Villiers.

Bibliographic data for Niger: South of Aïr Mountains, 525 m, Sept. 1947, Chopard L. & Villiers A. leg (Kaszab, 1953).

Geographic distribution: Angola, D.R. Congo, Ethiopia, Kenia, Mali, Mauritania, Mozambique, Namibia, Niger, Senegal, Somalia, Sudan, Tanzania, Yemen, Zimbabwe (Garcia-Rollan, 2012).

Remark: A very widespread species in Africa, maybe the most widely distributed species of the genus in Africa. The citation by Kaszab (1953) from Niger concerns the description of the subspecies *planicollis* based on a single female. The specimen I have studied was collected in a nearby locality by the same collectors, but this specimen corresponds to a typical *maculifrons*. Therefore I suspect that subspecies *planicollis* represents only an individual variation.

Cyaneolytta resplendens (Laporte de Castelnau, 1840)

Specimens studied: MHNG; 1 specimen; Niamey region, Niamey; collected Jul. 1956; leg Loups; det Z. Kaszab; – MNHN; 1 specimen; Zinder Region, Dungass; collected Sept.-Oct. 2010; leg R. Gaillard, Mission Tilho; det L. Casset.

Bibliographic data for Niger: Niamey (Pic, 1950).

Geographic distribution: Angola, Botswana, Ethiopia, Kenya, Malawi, Mozambique, Namibia, Niger, Senegal, Somalia, Sudan, Tanzania, Uganda, Zimbabwe (Garcia-Rollan, 2012).

Remark: A very widespread species in Africa, less common in western Africa than in the Eastern part.

Epicauta grandiceps (Haag-Rutenberg, 1880)

Specimens studied: MHNG; 4 specimens; Maradi Region, Maradi; 01.04.1980; leg H.E. Martin. – MHNG; 1 specimen; Tahoua Region, Tahoua; 29.08.1980; leg H. Guèvremont.

Geographic distribution: Chad, D.R. Congo, Eritrea, Ethiopia, Niger, Somalia, Sudan (Bologna, 1990).

Remark: The new data make Niger the westernmost area of the distribution of *Epicauta grandiceps*.

Psalydolytta jaloffa (Laporte de Castelnau, 1840)

Specimens studied: MHNG; 1 specimen; Tahoua Region, Tahoua; 29.08.1980; leg H. Guèvremont. – MHNG; 1 specimen; Zinder Region, Zinder; collected Aug. 1981; leg H.E. Martin. – MNHN; 1 specimen; Maradi Region, Tibiri; collected Jul. 1910; leg R. Gaillard, Mission Tilho.

Geographic distribution: D.R. Congo, Ethiopia, Ghana, Niger, Senegal, Sudan, Uganda (Selander, 1988b).

Remark: The new data confirm the presence of *Psalydolytta jaloffa* in the Sahel zone.

Psalydolytta leucophaea (Mäklin, 1875)

Specimens studied: MHNG; 1 specimen; Tahoua Region, Tahoua; 18.08.1980; leg H. Guèvremont.

Geographic distribution: Cameroon, Ghana, Niger, Senegal, Sudan (Selander, 1988b).

Remark: New country data for this species, the range of which seems discontinuous.

Psalydolytta vestita (Dufour, 1821)

Specimens studied: MHNG; 1 specimen; Tahoua Region, Tahoua; 30.08.1980; leg H. Guèvremont. – MHNG; 1 specimen; Zinder Region, Gomba; 29.08.1981; leg H.E. Martin.

Geographic distribution: Gambia, Mali, Mauritania, Niger, Senegal (Selander, 1988b).

Remark: New country data for this species, Niger becoming the easternmost location.

Croscherichia fulgurita (Reiche, 1865)

Specimens studied: MNHN; 1 specimen; Diffa Region, entre Komadougou et Manga; collected 1910; leg D. Noël; det M. Bologna.

Geographic distribution: Algeria, Egypt, Lybia, Mali, Marocco, Mauritania, Niger, Western Sahara (Bologna, 1990).

Remark: This species is adapted to desert ecosystems and is distributed throughout the Sahara Desert. On the label of the studied specimen is written Chad, but the locality is now in Niger. Bologna & Coco (1991) in their revision of the genus used this specimen to document the presence in Chad. Chad was therefore removed from the distribution list and replaced by Niger.

Hycleus abiadensis (Marseul, 1870)

Specimens studied: MNHN; 1 specimen; Dosso Region, de Gaya à Say, river bank Niger; collected Febr. 1910; leg R. Gaillard, Mission Tilho. – MNHN; 2 specimens; Maradi Region, Tibiri; collected Jul. 1910; leg R. Gaillard, Mission Tilho.

Bibliographic data for Niger: Tanout (Pardo Alcaide, 1963a).

Geographic distribution: Chad, Niger, Sudan (Pardo Alcaide, 1963a).

Remark: The known distribution of this big and attractive species was quite limited, but the two new localities are very close to Benin (Gaya à Say) and Nigeria (Tibiri) and the species will likely also be found in these two countries in the future.

Hycleus adrarensis (Pic, 1942) bona species comb. nov.

Fig. 2

Zonabris adrarensis Pic, 1942: 78.
Zonabris adrarensis. – Pardo Alcaide, 1962: 218, synonym of *Mylabris brunnipes* (Klug, 1845).
Gorrizia kaszabi Pardo Alcaide, 1968: 624, figs 1-5 **syn. nov.**

Specimens studied: MNHN; 2 specimens; Agadez Region, Arlit, Aïr Mountains; collected Sept. 1968; leg R. Villemain. – MNHN; 11 specimens; Diffa Region, N'Guigmi; collected Jul.-Aug. 1919; leg D. Noël.

Specimens studied for Mali: MNHN; 2 specimens; Gao Region, Bamba; collected Jul. 1909; Leg R. Chudeau. – MNHN; 3 specimens; Tombouctou Region, Azawad, Amaiort; collected Aug. 1909; leg R. Chudeau. – MNHN; 1 specimen; Tombouctou Region, Goundam; collected Sept. 1909; leg R. Chudeau.

Specimens studied for Chad: MNHN; 1 specimen; Borkou Region, Faya, Elléla; 19.08.1935; Mission d'étude de la biologie des Acridiens. – MNHN; 3 specimens; Ennedi Region, Fada, Archei; 07.09.1935; Mission d'étude de la biologie des Acridiens. – MNHN; 1 specimen; Ennedi Region, Mortcha, Ouadi Souala, 12/13.09.1935, Mission d'étude de la biologie des Acridiens. – MNHN; 1 specimen; Kanem Region, Mao à N'Guigmi: collected Sept. 1910; leg R. Gaillard, Mission Tilho.

Bibliographic data for Niger: Agadez, Aïr Sud, 525 m, 25/28-VIII-1947 (Pic, 1950); Air, between Talak and Iferovane (Bologna & Turco, 2007 as *Hycleus kaszabi*).

Geographic distribution: Chad, Mali, Mauritania, Niger, Sudan (Bologna & Turco, 2007).

Remark: Maurice Pic (1942) described this species from Adrar des Iforas (South-Eastern Mauritania), and noticed its close relationships with *H. brunnipes* (Klug, 1845). Twenty years later, Anselmo Pardo-Alcaide (1962) synonymized *H. adrarensis* with *H. brunnipes*, based on the study of a specimen identified by Pic from Agadez (IFAN collection). Only six years later, he described a new species belonging to the *brunnipes*-group from Sudan and Mauritania, *H. kaszabi* (Pardo Alcaide, 1968). All the studied specimens fit perfectly with the complete description by Pardo-Alcaide, including the single specimen identified by Pic as *H. adrarensis* (Agadez, MNHN).

This species was so far only known from a few localities in different countries. In the MNHN's collection, I identified other specimens from 7 additional localities and two new countries. Based on this material, *H. adrarensis* is also present in Mali and Chad and its Sahelian distribution appears wider than previously known. A map with all known localities is presented in Figure 3.

Fig. 2. Dorsal view of the habitus of *Hycleus adrarensis* (Pic, 1942). Specimen MNHN, Agadez Region, Arlit, Aïr Mountains, collected Sept. 1968. (photo A. Mantilleri)

Fig. 3. Distribution of *Hycleus adrarensis* (Pic, 1942)

Hycleus affinis (Olivier, 1811)

Specimens studied: MHNG; 2 specimens; Maradi Region, Maradi; collected Aug. 1981; leg H.E. Martin. – MHNG; 1 specimen; Niamey region, Niamey; collected Jul. 1956; leg Loups; det Z. Kaszab. – MHNG; 2 specimens; Tahoua Region, Tahoua; collected Febr. 1981; leg H.E. Martin. – MHNG; 8 specimens; Zinder Region, Gomba; 29.08.1981; leg H.E. Martin. – MHNG; 1 specimen; Zinder Region, Kagwa; 30.09.1980; leg H.E. Martin. – MHNG; 1 specimen; Zinder Region, Mirya; 20.09.1980; leg H.E. Martin. – MHNG; 33 specimens; Zinder Region, Zinder; collected Aug. 1981; leg H.E. Martin. – MNHN; 18 specimens; Zinder Region, Dungass; collected Sept.-Oct. 2010; leg R. Gaillard, Mission Tilho. – MFC; 8 specimens; Tillaberi Region, Kouré; collected Sept. 2002; leg P. Juhel.

Geographic distribution: Benin, Burkina Faso, Cameroon, Chad, D.R. Congo, Gambia, Ghana, Guinea, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo (Bologna, 1994).

Remark: This is the first record of this species for Niger, although it seems to be the most common species of Meloidae of this country.

Hycleus argentatus (Fabricius, 1792)

Specimens studied: MHNG; 4 specimens; Zinder Region, Gomba; 29.08.1981; leg H.E. Martin. – MHNG; 1 specimen; Zinder Region, Mirya; 29.09.1980; leg H.E. Martin. – MHNG; 2 specimens; Zinder Region, Zinder; collected Aug. 1981; leg H.E. Martin. – MNHN; 6 specimens; Diffa Region, N'Guigmi; collected Jul.-Aug. 1919; leg D. Noël. – MNHN; 1 specimen; Maradi Region, Tibiri; collected Jul. 1910; leg R. Gaillard, Mission Tilho. – MFC; 1 specimen; Tillaberi Region, Kouré; collected Sept. 2002; leg P. Juhel.

Bibliographic data for Niger: Agadez, Monts Tarraouaji (Pic, 1950).

Geographic distribution: Burkina Faso, Chad, Eritrea, Ethiopia, Ghana, Guinea, Mauritania, Niger, Senegal, Somalia, Sudan (Bologna, 1990).

Remark: Egypt is excluded from the distribution of this species, since all examined specimens seen from this country belong to *Hycleus ocellatus* (Olivier, 1790), like a specimen from Cairo in the MHNG identified as *H. argentatus* by M. Magistretti.

Hycleus chevrolati (Beauregard, 1889)

Specimens studied: MHNG; 3 specimens; Dosso Region, Gaya; 02/09.09.1980; leg H.E. Martin.

Geographic distribution: Gambia, Ghana, Niger, Senegal (Kaszab, 1981b).

Remark: First citation for Niger. All records from eastern Africa actually belong to the closely similar species *Hycleus zavattarii* (Gridelli, 1939).

Hycleus dubiosus (Marseul, 1870)

Specimens studied: MHNG; 1 specimen; Zinder Region, Zinder; collected Aug. 1981; leg H.E. Martin.

Geographic distribution: D.R. Congo, Egypt, Eritrea, Ethiopia, Kenia, Mozambique, Niger, Rwanda, Somalia, Sudan, Tanzania, Uganda (Bologna, 1990).

Remark: This first record for Niger is unexpected for this species from East Africa.

Hycleus fimbriatus (Marseul, 1872)

Specimens studied: MHNG; 1 specimen; Tillabéri Region, Tillabéri; 25.09.1980; leg H.E. Martin. – MHNG; 5 specimens; Zinder Region, Zinder; collected Aug. 1981; leg H.E. Martin. – MNHN; 31 specimens; Diffa Region, N'Guigmi; collected Jul.-Aug. 1919; leg D. Noël. – MNHN; 13 specimens; Zinder Region, Dungass; collected Sept.-Oct. 2010; leg R. Gaillard, Mission Tilho.

Bibliographic data for Niger: Agadez, Dabaga (Pic, 1950).

Geographic distribution: Chad, Mauritania, Niger, Senegal, Sudan (Bologna, 1985).

Remark: A typical species from the Sahel region.

Hycleus nigriplantis (Klug, 1845)

Specimens studied: MHNG; 2 specimens; Zinder Region, Zinder; collected Aug. 1981; leg H.E. Martin. – MNHN; 2 specimens; Agadez Region, Arlit, Aïr Mountains; collected Sept. 1968; leg R. Villemain.

Bibliographic data for Niger: Agadez, Monts Tarraouaji (Pic, 1950).

Geographic distribution: Chad, Ethiopia, Israel, Mauritania, Niger, Saudi Arabia, Senegal, Somalia, Sudan, Yemen (Bologna & Turco, 2007).

Remark: Another species confined to the Sahelian ecoregion.

Hycleus nubicus (Marseul, 1872) comb. nov.

Specimens studied: MNHN; 1 specimen; Maradi Region, Tibiri; collected Jul. 1910; leg R. Gaillard, Mission Tilho.

Bibliographic data for Niger: Agadez, Dabaga, Tanout (Pardo Alcaide, 1963b).

Geographic distribution: Mali, Mauritania, Niger, Senegal, Sudan (Bologna, 1985).

Remark: Another typical Sahelian species of this beetle family.

Hycleus pallipes (Olivier, 1811) comb. nov.

Specimens studied: MNHN; 17 specimens; Zinder Region, Dungass; collected Sept.-Oct. 2010; leg R. Gaillard, Mission Tilho.

Geographic distribution: Cameroon, Gambia, Mauritania, Niger, Senegal (Bologna, 1985).

Remark: This common Western African species was never recorded before from Niger.

Hycleus senegalensis (Voigts, 1902)

Specimens studied: MHNG; 1 specimen; Niamey Region, Niamey; collected Nov. 1956; leg Loups; det Z. Kaszab. – MHNG; 3 specimens; Niamey Region, Niamey; leg H.E. Martin. – MHNG; 1 specimen; Tillabéri Region, Tillabéri; 05.09.1980; leg P. Bouchard. MFC; – 2 specimens; Tillabéri Region, Kouré; collected Sept. 2002; leg P. Juhel.

Specimens studied from Nigeria: MHNG; 1 specimen; Yobe Region, Nguru; collected Nov. 1951, det Z. Kaszab.

Bibliographic data for Niger: Ile Boubou (Bologna, 1994).

Geographic distribution: Angola, Burkina Faso, Cameroon, D.R. Congo, Eritrea, Ethiopia, Gabon, Ghana, Ivory Coast, Mauritania, Niger, Nigeria, P.R. Congo, Senegal, Sierra Leone, Tanzania, Togo (Bologna, 1994).

Remark: The data from Eastern Africa need to be confirmed for this very common West-African species. Niger is here added to the distribution based on a specimen from the Yobe Region.

Hycleus vicinalis (Marseul, 1872) comb. nov.

Specimens studied: MNHN; 17 specimens; Zinder Region, Dungass; collected Sept.-Oct. 2010; leg R. Gaillard, Mission Tilho.

Geographic distribution: Chad, Niger, Sudan (Pardo-Alcaide, 1963a).

Remark: A little known species, probably often confused in collection with *H. affinis*. This new country record is the westernmost for the species.

Nemognatha risbeci Pic, 1951

Specimens studied: MNHN; 1 specimen; Zinder Region, Zinder; collected Jan. 1906; leg R. Chudeau.

Specimens studied from Mali: MNHN; 1 specimen; Kayes Region, Kayes; collected 1899; leg G. Massiou.

Geographic distribution: Gambia, Mali, Niger, Senegal (Kaszab, 1981a).

Remark: An uncommon species, new for both Niger and for Mali. This species seems to be restricted to the western part of the Sahelian ecoregion.

CONCLUSION

Until now only 19 species of Meloidae were known from Niger (see citations in species treatments above). *Hycleus brunnipes* must be withdrawn from Niger and Mauritania (Pardo-Alcaide, 1962) as its distribution is strictly Palearctic. Thirteen species are here added to this list, resulting in 31 species known to occur in Niger:

Lydomorphus (L.) angusticollis (Haag-Rutenberg, 1880)
Lydomorphus (L.) melanocephalus (Fabricius, 1801)
Lydomorphus (L.) pilitarsis (Kaszab, 1955)
Lydomorphus (Pardolydus) dusaulti (Dufour, 1821)
Cyaneolytta airensis Pic, 1950
Cyaneolytta chopardi Pic, 1950
Cyaneolytta maculifrons (Mäklin, 1875)
Cyaneolytta resplendens (Laporte de Castelnau, 1840)
Epicauta fasciceps (Walker, 1871)
Epicauta grandiceps (Haag-Rutenberg, 1880)
Epicauta oculata (Fabricius, 1792)
Psalydolytta jaloffa (Laporte de Castelnau, 1840)
Psalydolytta leucophaea (Mäklin, 1875)
Psalydolytta vestita (Dufour, 1821)
Croscherichia fulgurita (Reiche, 1865)
Hycleus abiadensis (Marseul, 1870)
Hycleus adrarensis (Pic, 1942)
Hycleus affinis (Olivier, 1811)
Hycleus argentatus (Fabricius, 1792)
Hycleus chevrolati (Beauregard, 1889)
Hycleus dubiosus (Marseul, 1870)
Hycleus fimbriatus (Marseul, 1872)
Hycleus nigriplantis (Klug, 1845)
Hycleus nubicus (Marseul, 1872)
Hycleus pallipes (Olivier, 1811)
Hycleus senegalensis (Voigts, 1902)
Hycleus terminatus (Illiger, 1800)
Hycleus vicinalis (Marseul, 1872)
Horia fabriciana Betrem, 1929
Synhoria nitida Gahan, 1909
Nemognatha risbeci Pic, 1951

This list is not definitive and some common species of the Sahelo-Sudanian zone have still not been collected in Niger: *Epicauta villosa*, *Lydomorphus (L.) kulzeri, Cyaneolytta deyrollei* or *C. fryi.* Two new species were also added for Mali (*Hycleus adrarensis* and *Nemognatha risbeci*), one for Chad (*Hycleus adrarensis*) and one for Nigeria (*Hycleus senegalensis*)

Most of the species have a Sahelo-Sudanian distribution, some from the West coast to the East coast of Africa [*Lydomorphus (Pardolydus) dusaulti, Epicauta fasciceps, Psalydolytta jaloffa*]; some are known from Western Africa only [*Lydomorphus (L.) melanocephalus, L. (L.) pilitarsis, Epicauta oculata, Psalydolytta leucophaea, P. vestita, Hycleus affinis, H. argentatus, H. chevrolati, H. pallipes, H. senegalensis, H. terminatus, Nemognatha risbeci*]. Another numerous group is that of species restricted to the Sahelian region (*Hycleus adrarensis, H. fimbriatus, H. nubicus*); some of which occur in the central Sahel zone only (*Cyaneolytta airensis, C. chopardi*) and some in the eastern Sahelian zone (*Epicauta grandiceps, Hycleus abiadensis, H. vicinalis*). At last one is a Saharan species (*Croscherichia fulgurita*). Few species have a widespread distribution in most of Africa (*Cyaneolytta maculifrons, C. resplendens, Horia fabriciana*) or just in Eastern Africa (*Hycleus dubiosus*) or central Africa (*Synhoria nitida*), one species is a Sahelian species with an extension into the Arabian Peninsula (*H. nigriplantis*); one species has a peculiar distribution towards western India [*Lydomorphus (L.) angusticollis*]. Only one of these species is endemic, *Cyaneolytta chopardi* which is known only from the Aïr mountains, but the status of this species is doubtful.

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Three new records of hydroids (Cnidaria: Hydrozoa) from southern Chile

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Abstract: Three new records of hydroids from the Chilean side of the Strait of Magellan are dealt with herein: *Symplectoscyphus marionesis* Millard, 1971 is redescribed, the occurrence of *Sertularella implexa* (Allman, 1888) in Chile is confirmed, and the new species *Egmundella magellanica* sp. nov. is described.

Keywords: Taxonomy - Chilean Patagonia - fjords - Southeast Pacific.

INTRODUCTION

During the last two decades, the hydrozoan fauna of Chile received increasing attention, with a series of taxonomic studies having been published on the group (Galea, 2007; Galea & Schories, 2012; Galea *et al*., 2007, 2009, 2014). An inventory of the invertebrate fauna of the country continues.

Influenced by waters of the Strait of Magellan, the Almirantazgo Sound is a deep and narrow inlet of the sea, about 80 km long, oriented NW to SE, and ending in Caleta María and Jackson Bay. On its southern coast lie three large bays (*viz.* Brookes, Ainsworth and Parry) connected to the Cordillera Darwin, the southernmost tip of the Andes. Several field trips and expeditions have been undertaken in recent years in southern Patagonia, but none of them focused on Parry Bay. The Wildlife Conservation Society, Punta Arenas, Chile, organized in February 2018 a survey to study the abundance and distribution of the commercial scallops *Zygochlamys patagonica* and *Chlamys vitrea*, and their associated fauna at Parry Bay. Both scallops are only fished by the native population. Sampling started in the Strait of Magellan and then along the Almirantazgo Sound, down to Parry Bay (Fig. 1). Among other animal groups sampled, three hydroid species, representing new records for Chile, are discussed herein.

MATERIAL AND METHODS

Sampling was done, using SCUBA, by two of us (DS and JH). The collected specimens were fixed in 10% formalin in seawater, and observations were done on preserved material using the methods described in Galea (2007). The study material is deposited in collections of the Muséum d'histoire naturelle de Genève, Switzerland, whose catalogue numbers are indicated by MHNG-INVE- followed by 6-digit numbers.

TAXONOMY AND RESULTS

Order Leptothecata Cornelius, 1992
Family Symplectoscyphidae Maronna *et al*., 2016
Genus *Symplectoscyphus* Marktanner-Turneretscher, 1890

Symplectoscyphus marionensis Millard, 1971

Figs 2-3; Table 1

Symplectoscyphus marionensis Millard, 1971: 405, fig. 7. – Blanco, 1980: 200, figs 6-13. – Blanco, 1984: 261, figs 1, 2. – Branch & Williams, 1993: 13, unnumbered fig. – Blanco, 1994a: 154. – Blanco, 1994b: 204.

Material examined: MHNG-INVE-129717; Chile, Región de Magallanes y de Antártica Chilena, Strait of Magellan, Stn. 1, WGS84: -53.82408 -71.06608,

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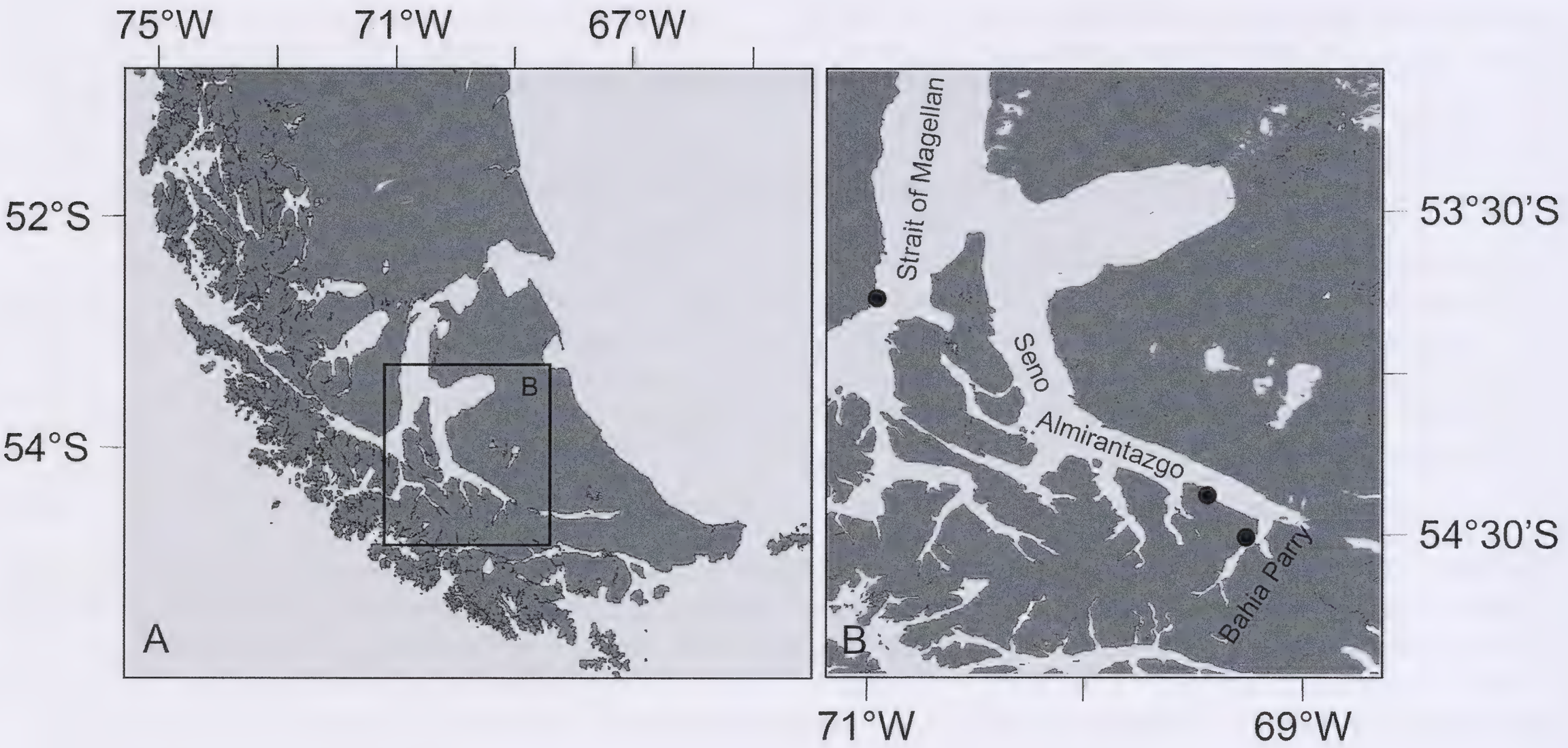


Fig. 1. Map of southern Chile and detail of the study area with the sampling stations.

5-10 m, coll. Schories & Holtheuer, 01.02.2018; fertile colony on crab carapace.

Description: Colony composed of numerous erect (though unable to support themselves when out of liquid), simple, monosiphonic, up to 2.5 cm high, stems arising from tubular, irregularly-branched hydrorhiza creeping on surface of a crab carapace; perisarc rather thick, striated obliquely, and straw-colored to transparent. Stems with a number of spiral twists (1 to 4 observed) just above their origin from the stolon, then divided into regular internodes by means of deep, oblique constrictions of the perisarc slanting in alternate directions; perisarc thick, with smooth surface, brownish at nodes and straw-colored to transparent elsewhere. Internodes short, slightly geniculate, swollen proximally, then gradually yet distinctly expanding so as to accommodate laterally a hydrotheca, just below the distal node. Side branches pinnately-arranged along the stem and with similar structure, generally given off singly, every 4 stem hydrothecae, by means of short, swollen apophyses borne immediately below the hydrothecal bases. Not rarely, apophyses arise more irregularly, every 1 to 9 hydrothecae, depending on the development of the colony. Branches are generally alternate along the stem. Apophyses are given off on one side of the hydrothecae, not laterally so as to form a coplanar structure; thus, the resulting colony is three-dimensional, displaying decidedly a frontal and a dorsal side, the majority of branches being shifted on anteriorly, forming a wide angle between the two rows. Occasionally, apophyses are also, here and there, given off posteriorly, but this does not alter maintenance of the pinnate structure of the colony. In addition, couples of branches may be rarely given off from both sides of a hydrotheca, forming pairs flanking that theca. Aberrant origins for the side branches are to be found from within some incompletely-formed stem hydrothecae. Main branches rebranch again, forming up to 5th order branches. In all cases, the lower-order branches are significantly shifted with respect to their preceding counterparts, since the apertures of their hydrothecae are situated in a plane forming an almost right angle with that of the hydrothecae belonging to the immediately higher-order branch: while the stem hydrothecae are shifted on to the anterior side of the colony, those of the 1st order branches face upwards, and so on. First internode of a side branch slightly longer than the subsequent ones, with a couple of proximal twists of the perisarc; ordinary internodes of comparable length to those of the stem. Occasionally, clinging organs are given off from tips of both stem and branches, below the hydrothecae; multilobate, flattened laterally, with thick perisarc, gradually becoming thinner towards tips. Hydrothecae alternate, in two parallel rows, generally forming a right angle, occasionally more or less pronounced; tubular, 36-45% adnate to the corresponding internode, gently curving upwards and outwards; free adaxial and abaxial walls slightly convex, with smooth perisarc, comparatively thinner on the former; a perisarc plug at junction between the adnate adaxial wall and the base, occasionally with large, rounded fenestra immediately below or slightly overlapping the base; aperture distinctly thickened, provided with 3 conspicuous, pointed triangular cusps with rounded tips, one adaxial and two latero-abaxial, separated by deep, rounded embayments;

adaxial cusp distinctly produced and comparatively less developed than its lateral counterparts; no internal, submarginal cusps; renovations occasional, occurring generally singly. Gonothecae borne on both stems and side branches, predominant on the latter; arising singly, immediately below the hydrothecal bases, on one side of the theca, to which one of their basal walls is apposed, being thus flattened there; sex not determinable in the present material; elongated-oval, tapering below into an indistinct pedicel, above transversely wrinkled, with 6 to 8 complete annular ridges, not forming a spiral, and gradually fading away proximally; distally a rounded, slightly depressed plateau on the top of which is inserted a short, terminal tube, imperceptibly constricted in middle, occasionally somewhat flared at aperture. Cnidome: small and large, banana-shaped microbasic mastigophores, none seen discharged.

Dimensions: See Table 1.

Remarks: The characteristic, unilateral branching pattern met with in *S. marionensis* results in colonies whose appearance (Fig. 2) resembles that of *S. allmani* Hartlaub, 1901, described by Galea *et al.* (2017). This feature was not particularly emphasized by Millard (1971) in her original account, although it is evident from her fig. 7D. The mode of branching and the shape of its gonotheca (her figs 7C and 7B, respectively) leave little doubt that we are dealing with the same species.

A redescription of *S. marionensis*, based on material from Staten Island, Argentina, was given by Blanco (1980), who was able to compare her specimens to the holotype. In her account, the unilateral position of hydrothecae and branches, as well as the thickening of the hydrothecal rim, are clearly emphasized.

The size of the colonies reaches as much as 5 cm (Blanco, 1980) or 6 cm (Millard, 1971) high. Millard (1971) observed terminal stolonization in her material, while clinging organs occur in ours.

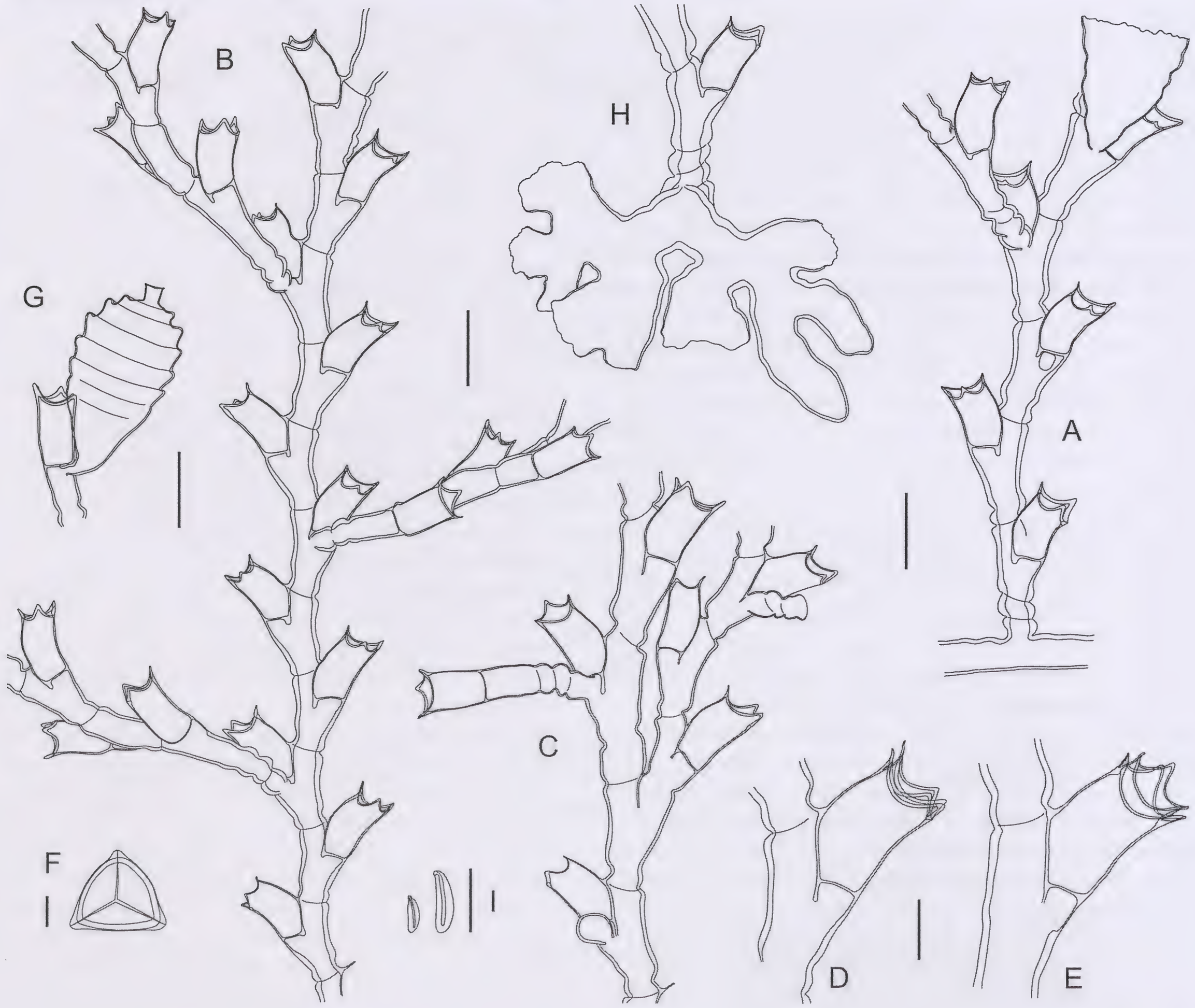
A number of additional nominal species of *Symplectoscyphus* occur along the coasts of South America, namely: *S. affinis* (Hartlaub, 1901) (Hartlaub, 1905), *S. bathyalis* Vervoort, 1972 (original account),

Table 1. Measurements of *Symplectoscyphus marionensis* Millard, 1971, in μm.

	Present study	Millard (1971) holotype	Blanco (1980)
Stolon			
- diameter	205-250	-	180-380
Internodes			
- 1st internode, length	780-890	-	-
- ordinary internode, length	465-680	630-800	400-580
- diameter at node	120-210	-	160-290
- apophysis for branch, length	145-205	-	-
Hydrothecae			
- abaxial length	340-370	330-620	410-470
- free adaxial length	315-390	360-480	290-350
- adnate adaxial length	190-260	220-340	190-270
- free adaxial/adnate adaxial wall ratio	1.18-1.95	-	-
- adnate part/ adaxial wall ratio	0.36-0.45	0.34-0.49	-
- base width	160-180	-	-
- maximum width	240-280	-	280-310
- diameter at aperture	230-270	270-300	250-270
Gonotheca			
- total length	1325-1730	1260-2230	1580-1930 (♀)
- maximum width	550-720	500-930	640-880 (♀)
- tube length	105-130	-	110-150 (♀)
- tube width in middle	100-125	-	-
- tube diameter at aperture	115-135	-	210-240 (♀)
Cnidome			
- small mastigophores (length × width)	(5.9-6.2) × (1.8-1.9)	-	-
- large mastigophores (length × width)	(8.9-9.9) × (2.5-2.7)	-	-

Fig. 2. *Symplectoscyphus marionensis* Millard, 1971. Macrophotograph of a preserved fertile stem highly invested by a colony of *Campanularia lennoxensis* Jäderholm, 1903. Scale bar: 0.5 cm.

Fig. 3. *Symplectoscyphus marionensis* Millard, 1971. (A) Basal part of a colony. (B) Portion of stem with proximal part of three consecutive side branches arising through apophyses below the stem hydrothecae. (C) Aberrant origin of a branch from within a hydrotheca. (D) Hydrothecae from proximal part of a stem, (E) from a branch, and (F) aperture with its closing apparatus in frontal view. (G) Gonotheca and its relative position to the corresponding hydrotheca, seen laterally. (H) Clinging organ borne on middle portion of a branch. (I) Cnidome. Scale bars: 10 µm (I), 100 µm (F), 200 µm (D, E), 500 µm (A-C, G, H).



S. chubuticus El Beshbeeshy, 2011 (original account), *S. filiformis* (Allman, 1888) (Galea, 2007; Galea & Schories, 2012), *S. flexilis* (Hartlaub, 1901) (Galea & Schories, 2012; Galea *et al*., 2014), *S. interruptus* (Pfeffer, 1889) (Galea & Schories, 2012), *S. leloupi* El Beshbeeshy, 2011 (original account; Galea *et al*., 2009), *S. magellanicus* (Marktanner-Turneretscher, 1890) (Galea, 2007; Galea & Schories, 2012), *S. milneanus* (d'Orbigny, 1842) (Galea *et al*., 2009), *S. modestus* (Hartlaub, 1901) (Hartlaub, 1905), *S. paraglacialis* El Beshbeeshy, 2011 (original account; Galea & Schories, 2012), *S. patagonicus* Galea & Schories, 2012 (original account), *S. salvadorensis* El Beshbeeshy, 2011 (original account), *S. semper* Galea & Schories, 2014 (Galea *et al*., 2014), *S. singularis* El Beshbeeshy, 2011 (original account), *S. subarticulatus* (Coughtrey, 1875) (Galea *et al*., 2014), *S. unilateralis* (Lamouroux, 1824) (Galea *et al*., 2014), *S. valdesicus* El Beshbeeshy, 2011 (original account), and *S. vervoorti* El Beshbeeshy, 2011 (original account).

Symplectoscyphus affinis was regarded as a junior synonym of *S. magellanicus* by Vervoort (1972). So were *S. modestus* and *S. interruptus* by Galea & Schories (2012). These statements, however, require a reexamination of the types to be confirmed.

Among the nominal species listed above, *S. marionensis* is distinctive through its unilateral arrangement of both hydrothecae and side branches, a condition only encountered in the stems of the otherwise rarely branched *S. unilateralis*. However, their respective gonothecae are morphologically different, and the trophosome of the latter is comparatively smaller in all proportions.

It should be also noted that side branches of *S. marionensis* are not given laterally, but from insertion points in front or the rear side of its hydrothecae, just below their bases, and consequently do not lie in one plane with the stem (Fig. 3B). A similar branching pattern, with no true axillar hydrothecae, is also met with in some other congeners, *e.g. S. flexilis* (fig. 6C in Galea & Schories, 2012; fig. 4E[1] in Galea *et al*., 2014) and *S. paraglacialis* (fig. 6L in Galea & Schories, 2012).

Distribution: South-African sub-Antarctic islands – Marion Island [Prince Edwards islands, (Millard, 1971)]. Argentina – Isla de los Estados (Blanco, 1980, 1984, 1994b). Chile – Región de Magallanes y Antártica Chilena [Strait of Magellan (present study)].

Family Sertularellidae Maronna *et al*., 2016
Genus *Sertularella* Gray, 1848

Sertularella implexa (Allman, 1888)

Figs 4-5; Table 2

Sertularia implexa p.p. Allman, 1888: 54, pl. 26 figs 1, 1a. – Hartlaub, 1901: 90. – Bedot, 1916: 223. – Galea *et al*., 2017: 282, figs 12B, 13A-D.

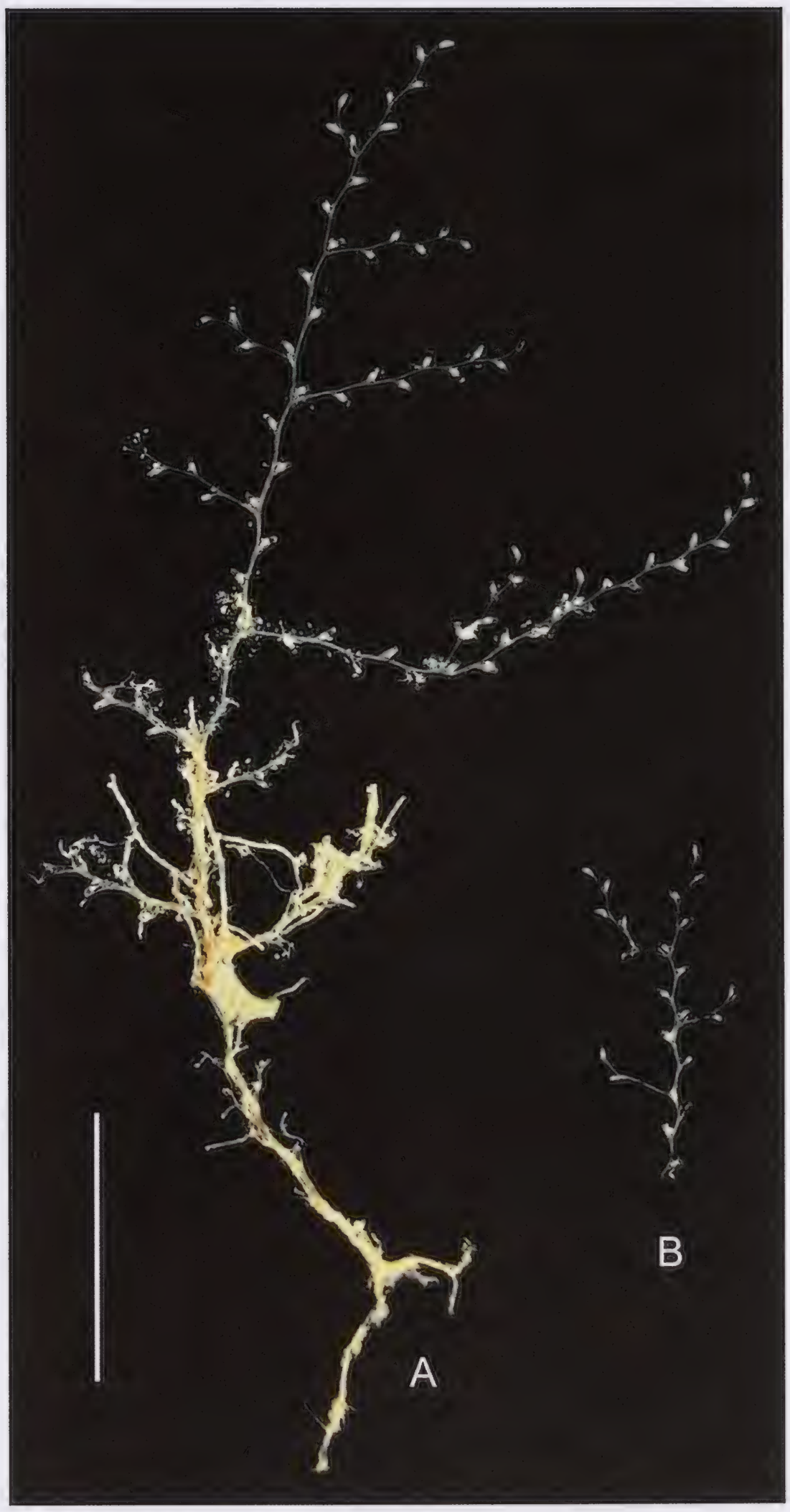


Fig. 4. *Sertularella implexa* (Allman, 1888). Preserved specimens from (A) MHNG-INVE-129724 and (B) MHNG-INVE-129727. Scale bar: 1 cm.

non *Sertularella implexa.* – Galea & Schories, 2012a: 40, pl. 3 fig. 4F-J (= *Sertularella recta* Galea & Schories, 2017).

Sertularella picta. – Vervoort, 1972: 113, figs 34, 35C [non *Sertularella picta* (Meyen, 1834) = *Sertularella gaudichaudi* (Lamouroux, 1824)].

non *Sertularella picta.* – Vervoort, 1972: 114, fig. 35A, B (= *Sertularella fuegonensis* El Beshbeeshy, 2011).

Material examined: MHNG-INVE-129724; Chile, Región de Magallanes y de Antártica Chilena, Bahía Parry, Stn. 3, WGS84: -54.64663 -69.38810, 10-20 m, coll. Schories & Holtheuer, 05.02.2018; five sterile colonies, 3.5-5.0 cm high. – MHNG-INVE-129727; Región de Magallanes y de Antártica Chilena, Bahía Parry, Stn. 3, WGS84: -54.64663 -69.38810, 10-20 m,

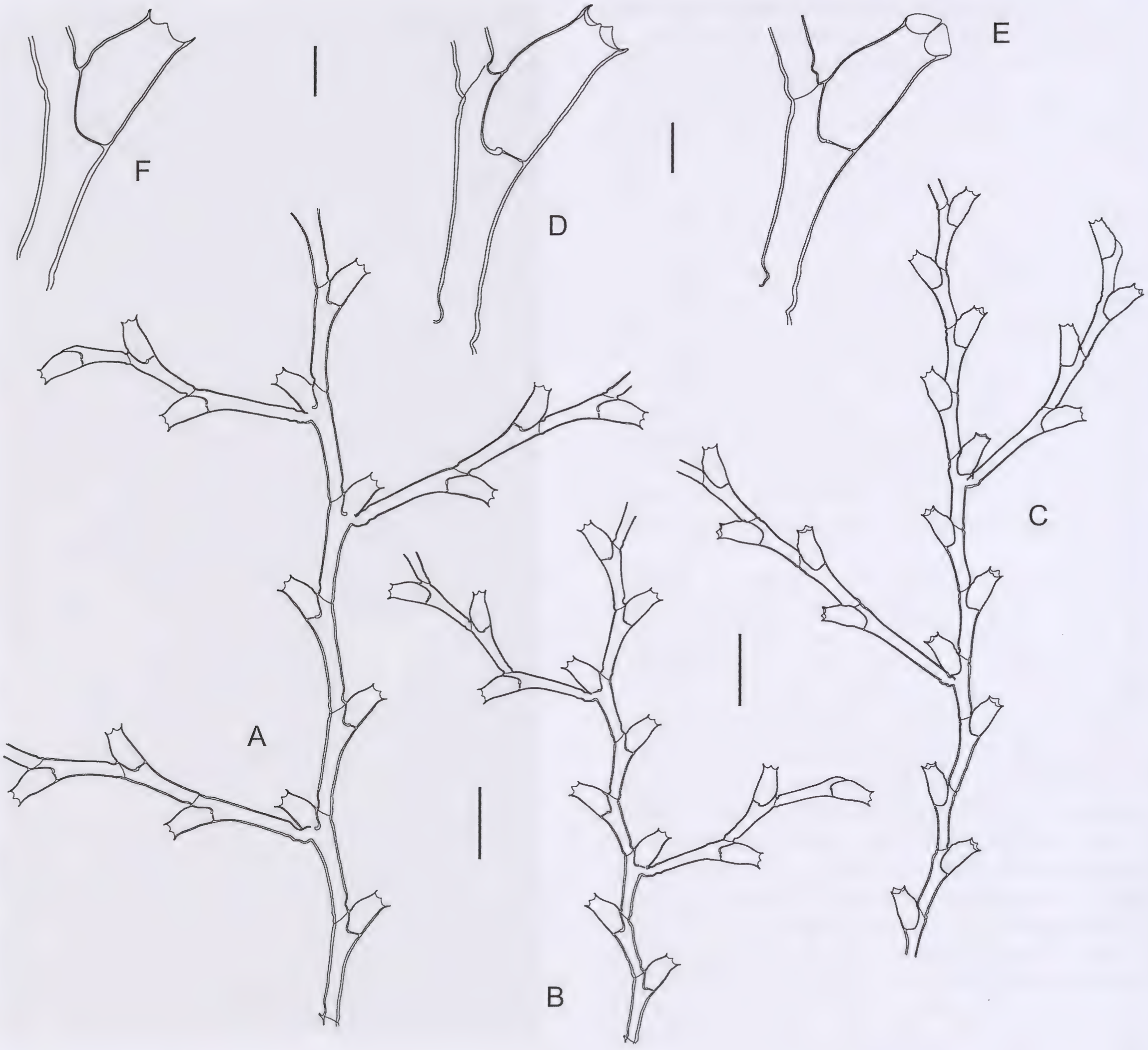


Fig. 5. *Sertularella implexa* (Allman, 1888). Fragments of colonies from (A) MHNG-INVE-129724 and (B) MHNG-INVE-129727. (C) Comparison with the holotype, NHML 1888.11.13.42 (Natural History Museum, London, United Kingdom), the latter reproduced from Galea *et al*. (2017). (D-F) Hydrothecae from the same sources, respectively. Scale bars: 200 µm (D-F), 1 mm (A-C).

coll. Schories & Holtheuer, 05.02.2018; three sterile stems, 0.9-1.2 cm high. – MHNG-INVE-129721; Región de Magallanes y de Antártica Chilena, Bahía Parry, Stn. 2, WGS84: -54.66090 -69.37640, 20-30 m, coll. Schories & Holtheuer, 03.02.2018; two sterile stems, 1.7 and 2.3 cm high.

Dimensions: See Table 2.

Remarks: The colonies from sample MHNG-INVE-129721 are similar to those from sample MHNG-INVE-129727 (Fig. 5B) regarding their small size and the length of their internodes, compared to the larger, yet still monosiphonic colonies with longer internodes present in sample MHNG-INVE-129724 (Fig. 5A). Despite these minor differences, all materials in hand show no specific differences with the type of *S. implexa* that was reexamined, redescribed and illustrated by Galea *et al*. (2017), and reproduced here in Fig. 5C. A comparison of their measurements is given in Table 2. Only branches of maximum 2nd order occur in the present material, with two consecutive branches being separated by 1-12 successive hydrothecae, the latter lying in one plane, and having the perisarc of their free adaxial wall smooth; their apertures may be renovated 1-3 times, and there are no internal, submarginal projections of the perisarc.

Table 2. Measurements of *Sertularella implexa* (Allman, 1888), in µm.

	Present study MHNG-INVE-129724	**Present study MHNG-INVE-129727**	**Galea *et al.* (2017) holotype NHM 1888.11.13.42**
Internode			
- ordinary internode, length	920-1530	845-995	690-1155
- 1st internode, length	1290-1740	1225-2185	1655-2010
- diameter at node	145-270	140-165	160-180
Hydrotheca			
- free adaxial length	410-440	410-445	360-440
- adnate adaxial length	300-325	235-255	255-290
- abaxial length	585-620	530-540	560-595
- base width	145-170	165-190	-
- maximum width	290-315	290-305	275-310
- diameter at aperture	240-260	220-245	195-235

As noted by these authors, the type material, as well as the present specimens, are sterile. Gonothecae are only known from the material likely incorrectly assigned by Vervoort (1972) to *S. picta* (Meyen, 1834), and believed to belong, with little doubt, to the present species (Galea *et al.*, 2017).

Distribution: Chile – Región de Magallanes y Antártica Chilena [off Isla Nueva (Vervoort, 1972, as *S. picta*), Bahía Parry (present study)]. Argentina – Provincia de Santa Cruz [off Deseado (Vervoort, 1972, as *S. picta*)]; Provincia de Tierra del Fuego, Antártida e Islas del Atlántico Sur [off Isla de los Estados (Vervoort, 1972, as *S. picta*)]. Between Cabo Virgenes and the Falkland Is. (Allman, 1888).

Family Campanulinidae Hincks, 1868
Genus *Egmundella* Stechow, 1921

Egmundella magellanica sp. nov.

Fig. 6; Table 3

Type material: MHNG-INVE-129725; Chile, Región de Magallanes y de Antártica Chilena, Bahía Parry, Stn. 3, WGS84: -54.64663 -69.38810, 10-20 m, coll. Schories & Holtheuer, 05.02.2018; profuse colony, epizoic on *Bougainvillia muscus* (Allman, 1863); gonothecae rare; at least one with intact gonophore.

Diagnosis: Colony stolonal with simple, pedicellate hydrothecae, nematothecae and gonothecae arising from creeping, branching, anastomosing hydrorhiza. Hydrotheca almost tubular, tapering slightly below and merging gradually and imperceptibly with its pedicel; basally a thin diaphragm, distally a filmy, pleated operculum, not delimited basally by crease line. Nematothecae elongate. Gonothecae long, tubular, smooth-walled, borne on pedicels of varied length, distally with pleated operculum. Gonophore a medusa.

Etymology: Named after its geographical area of occurrence, the Strait of Magellan.

Description: Colony stolonal, arising from branching, anastomosing hydrorhiza creeping on stem and branches of a hydroid host. Hydrothecae borne singly on top of pedicels of variable length; pedicels with a varied number (generally 2-4) of twists proximally, smooth or with scattered wrinkles elsewhere, though never below the hydrotheca; the latter almost tubular, gently tapering proximally and merging gradually and imperceptibly into its pedicel; separation marked by thin, though distinct, diaphragm; operculum consisting of the filmy, distal perisarc, forming contiguous triangular pleats (not distinct flaps) that meet centrally to form a pyramidal roof; no crease line between the hydrothecal wall and operculum. Hydranths with 22-24 filiform tentacles. Nematothecae scattered on hydrorhiza, pedicellate, with single, distal, ovoid chamber filled with a cluster of banana-shaped nematocysts; perisarc distinctly thickened on pedicel, comparatively thinner around the battery of nematocysts, leaving a small apical, circular aperture. Gonothecae arising from hydrorhiza, borne on either short, spirally-twisted or long, thin, centrally smooth pedicels; tubular, much longer and wider than the hydrothecae; perisarc smooth, except distally where it forms a pleated operculum around the distal aperture, similar to that of the hydrothecae. The gonophore, rather opaque in this fixed material, is most probably a medusa bud. Cnidome of the hydranth: small microbasic mastigophores; elongated-ovoid, unipolarly-curved haplonemes; long, thin, fusiform, gently curved heteronemes; long, fusiform, comparatively stouter heteronemes.

Table 3 (part). Morphological differences between the nominal species with *Campanulina*-like hydroids and stolonal nematothecae. Measurements in µm. C stands for *Cyclocanna* Bigelow, 1918, E for *Egmundella* Stechow, 1921, and O for *Oplorhiza* Allman, 1877.

	***Egmundella magellanica* sp. nov.**	***O. diaphragmata* Naumov, 1960**	***E. fasciculata* Fraser, 1940**	***E. gracilis* Stechow, 1921**	***E. grandis* Fraser, 1941**	***E. grimaldii* Leloup, 1940**	***E. humilis* Fraser, 1936**
Colony							
- stem condition	Monosiphonic, simple	Monosiphonic, either simple or ramified	Polysiphonic, ramified	Monosiphonic, simple	Monosiphonic, simple	Monosiphonic, simple	Monosiphonic, simple
Pedicel							
- length	1000-7000	-	-	(1) 2000-4000 (2) 286-703	*Ca.* 3000	*Ca.* 300	(1) < 400
- diameter	65-80	-	-	50-60	-	100	-
Hydrotheca							
- length	520-805	500-600	-	(2) 354-400	700-800	600-950	(1) *Ca.* 400
- max. width	160-210	250-300	-	(2) 131-143	-	300-400	
- diaphragm and width at this level	Present Width 100-135	Present -	Not stated -	(3) Present -	Not stated -	Present -	(2) Present -
Gonotheca							
- shape	Long, tubular, smooth-walled, borne on either short or exceedingly long pedicel; operculum pleated	Long, conical, borne on spirally-twisted pedicel. Identity not sure.	Not known	Not known	Not known	Not known	(2) Sessile, cylindrical, tapering abruptly below, wrinkled walls, operculum pleated
- height	2770-2845	-	-	-	-	-	(2) *Ca.* 700
- maximum width	430-490	-	-	-	-	-	(2) *Ca.* 300
Nematothecae							
- origin	Hydrorhiza	Hydrorhiza and hydrothecal pedicels	Accessory tubes and hydrothecal pedicels	Hydrorhiza and hydrothecal pedicels	Hydrorhiza and hydrothecal pedicels	Hydrorhiza	(1) Hydrorhiza
- shape	Elongated	Elongated	Globular	Elongated	Spherical	Elongated	Globular
- length	80-120	100-110	-	(1) *Ca.* 100 (2) 88-96	-	-	-
- max. width	30-35	50-60	-	(1) *Ca.* 40 (2) 43-45	-	30-40	-
Distribution	Southern Chile	Sea of Okhotsk (Russian Federation)	Off Martha's Vineyard (Massachusetts, USA)	(1) Vancouver (British Columbia, Canada) (2) Southern Chile	Off mouth of Chesapeake Bay (Virginia, USA)	Off Island of Newfoundland (Newfoundland and Labrador, Canada)	Sagami Bay (Japan)
Reference(s)	Present study	Naumov (1969)	Fraser (1940)	(1) Stechow (1921) (2) Galea (2007) (3) Present study	Fraser (1941)	Leloup (1940)	(1) Fraser (1936) (2) Hirohito (1995)

Table 3 (continued). Morphological differences between the nominal species with *Campanulina*-like hydroids and stolonal nematothecae. Measurements in µm. C stands for *Cyclocanna* Bigelow, 1918, E for *Egmundella* Stechow, 1921, and O for *Oplorhiza* Allman, 1877.

	***E. modesta* Millard & Bouillon, 1975**	***O. parvula* Allman, 1877**	***E. polynema* Fraser, 1948**	***C. producta* (G.O. Sars, 1874)**	***E. sibogae* Billard, 1940**	***E. superba* Stechow, 1921**	***E. valdiviae* Stechow, 1925**
Colony							
- stem condition	Monosiphonic, simple	Monosiphonic, simple	Monosiphonic, either simple or ramified	Monosiphonic, simple	Monosiphonic, simple	Monosiphonic, simple	Monosiphonic, simple
Pedicel							
- length	140-710	*Ca.* 200	< 3600 (simple), < 4500 (ramified)	3000-6000	80-825	(1) < 6000 (2) *Ca.* 8000	(1) 900-1000 (2) *Ca.* 675
- diameter	30-50	-	-	80-90	-	(1) *Ca.* 80	(1) *Ca.* 35
Hydrotheca							
- length	200-330	-	*Ca.* 1000	500-800	495-695	(1) *Ca.* 800 (2) *Ca.* 540	(2) *Ca.* 235
- max. width	80-110	-	*Ca.* 250	280-320	100-130	(1) *Ca.* 250 (2) *Ca.* 280	(1) *Ca.* 140 (2) *Ca.* 150
- diaphragm and width at this level	Present -	Present -	Present -	Present -	Reportedly absent -	Reportedly absent	Not detectable -
Gonotheca							
- shape	Not known	Not known	Sessile, long, tubular, striated longitudinally, operculum pleated	Fan-shaped, strongly flattened, borne on short pedicel; operculum slit-like	Long, tubular, smooth-walled, either sessile or borne on short pedicel, operculum pleated	Not known	Not known
- height	-	-	*Ca.* 1800	1500-4400	1190-1290	-	-
- maximum width	-	-	*Ca.* 250	1700-4600	220-315	-	-
Nematothecae							
- origin	Hydrorhiza	Hydrorhiza	Hydrothecal pedicels	Hydrorhiza	Hydrorhiza	Hydrorhiza	Hydrorhiza
- shape	Globular	Elongated	Elongated	Slightly elongated	Elongated	Elongated	Elongated
- length	40-50	-	-	60-100	-	(1, 2) *Ca.* 110	(1) *Ca.* 45 *(2) Ca.* 50
- max. width	20-40	-	-	-	-	-	(1) *Ca.* 20 (2) *Ca.* 22
Distribution	Mahé Island (Republic of Seychelles)	Marquesas Keys (Florida, USA)	Cedros Island (Baja California, Mexico)	N Atlantic to high Arctic	Between New Guinea and Seram; Sumbawa (Indonesia)	St. Thomas (US Virgin Islands)	W Sumatra (Indonesia)
Reference(s)	Millard & Bouillon (1975)	Allman (1877)	Fraser (1948)	Schuchert (2016)	Billard (1940)	(1) Stechow (1923) (2) Vervoort (1966)	(1) Stechow (1925) (2) Vervoort (1966)

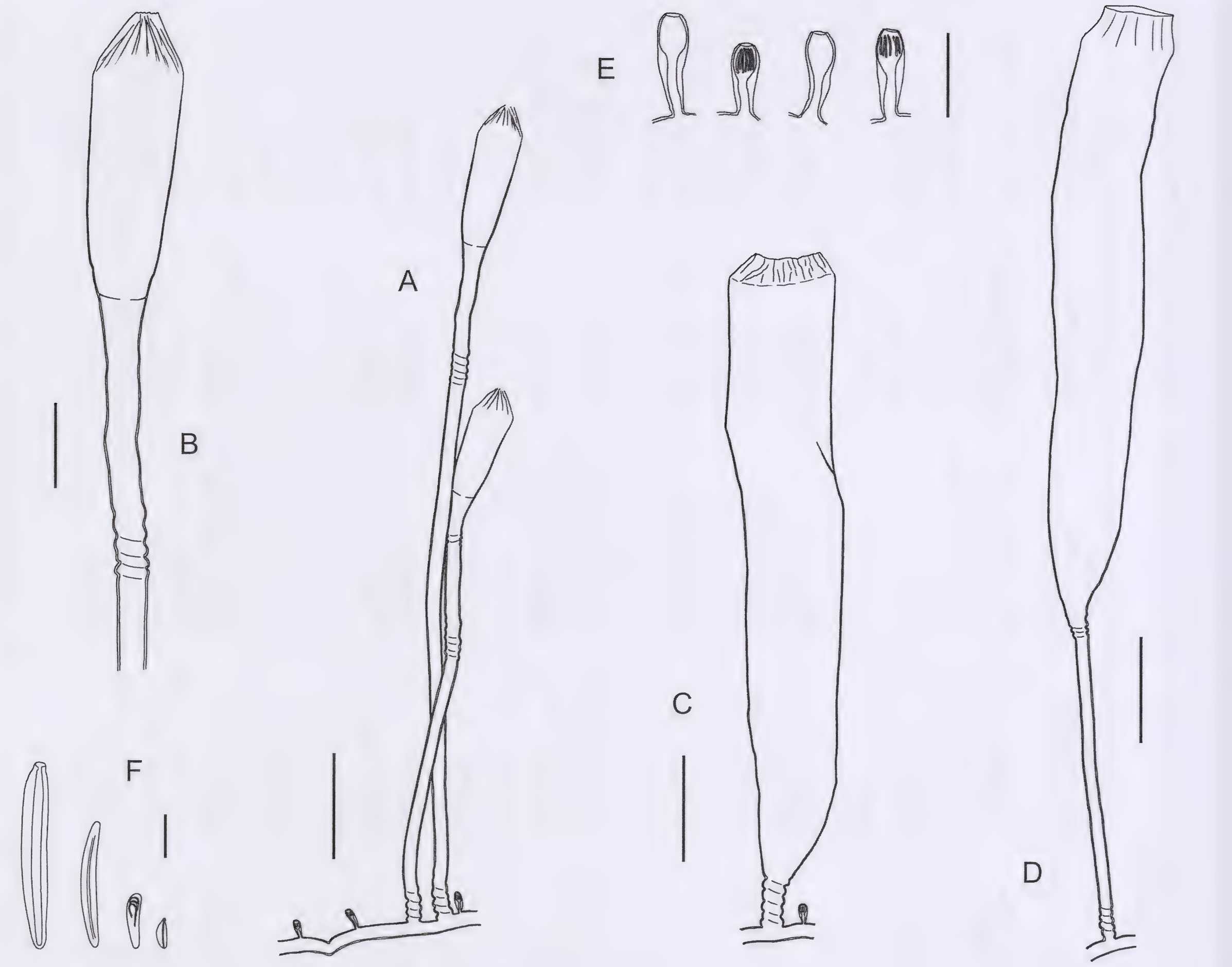


Fig. 6. *Egmundella magellanica* sp. nov. (A) Portion of hydrorhiza with two erect shoots and nematothecae. (B) Detail of a hydrotheca. (C) Gonothecae on short and (D) long pedicels. (E) Stolonal nematothecae, to show variation in shape and size. (F) Cnidome of the hydranth. Scale bars: 10 µm (F), 100 µm (E), 200 µm (B), 500 µm (A, C, D).

Dimensions: See Table 3 for measurements of the tropho- and gonosome, and a comparison with its congeners. Cnidome: microbasic mastigophores (7.2-7.4) × (2.0-2.3) µm, haplonemes (11.6-15.7) × (2.6-3.7) µm, small heteronemes *ca*. 27.9 × 3.8 µm, large heteronemes (39.8-43.0) × (5.6-6.2) µm.

Remarks: The current distinction between *Oplorhiza* Allman, 1877 and *Egmundella* Stechow, 1921 mainly relies in the shape of their hydrothecae, supposedly ovoid in the former, and funnel-shaped in the latter (Bouillon *et al*., 2006). This opinion follows Stechow (1921), who regarded *Egmundella* as not possessing ovoid hydrothecae, the latter showing an imperceptible transition with the hydrocaulus, marked by the presence of a reduced diaphragm. No modern redescription of *O. parvula* Allman, 1877, the type species of *Oplorhiza*, is available to date, in order to check this statement, given that illustrations of many hydroid species by Allman proved partly inaccurate (*e.g.* Billard, 1910). However, hydrothecae of *O. parvula* were originally described as "tubular" and "provided with a floor" (Allman, 1877), thus not essentially differing from those of *Egmundella*. Their supposedly ovoid shape is, in our opinion, not a reliable character supporting a generic separation. However, since hydroids belonging to these genera are not yet related to existing medusae, it is likely useless to consider assigning them a definitive taxonomic status. As most records of hydroids with *Campanulina*-like hydrothecae and stolonal nematothecae were assigned to *Egmundella*, this genus is retained to accommodate the hydroid described herein.

Ten nominal species have been assigned so far to *Egmundella*, two others to *Oplorzhiza*, and one to *Cyclocanna* Bigelow, 1918 (Table 3). Although the

trophosomes of most appear morphologically uniform, differences in the condition of the stem, the size of the hydrothecae and the shape and position of the nematothecae, could be noted. Gonothecae have been rarely observed in a few species but, when known, they provide reliable characters for a specific separation. In one instance, it has been demonstrated that *Cyclocanna welshi* Bigelow, 1918 is the medusa stage of the hydroid *Egmundella producta* (G.O. Sars, 1874), providing a new nomenclatural combination for this animal, as *Cyclocanna producta* (G.O. Sars, 1874) (Schuchert *et al*., 2017).

In *Egmundella gracilis* Stechow, 1921, type species of the genus, the hydrothecal wall does not form a crease line at junction with the operculum ["Das Operculum bildet mit der Thekenwand keinen besonders scharfen Rand" (Stechow, 1921)], and this statement is also stressed in the diagnosis of the genus. Although not expressly indicated, but obvious from Stechow's (1923) fig. Q, the operculum results from a modification of the distal hydrothecal wall, the latter being filmy and pleated there, so as to form a pyramidal roof. In addition, the nematothecae were described as short pedicellate, spherical, monothalamic and immovable ["kurzgestielte, kugelige, einkammerige, unbewegliche Nematophoren mit dicker Peridermwand und einem dicken Bündel sehr großer, langer Nesselkapseln" (Stechow, 1921)].

Although the nematothecae of *O. parvula* are reportedly said to be pedicellate ["in the form of tubular receptacles with an orifice in the summit" (Allman, 1877: 14)], it is not clear whether its hydrothecae possess a pleated operculum. Indeed, the latter is said "cut into thin collapsible segments" (Allman, 1877: 14), and is depicted as such [Allman's (1877) pl. 7 fig. 2].

Available descriptions of a few nominal species, assigned to either *Egmundella* or *Oplorhiza*, suggest that they may possess hydrothecal opercula composed of multiple, distinct flaps, with or without a basal crease line. It is not clear whether this is a normal condition, or these flaps result from the tearing of the filmy, distal, thecal perisarc. For example, the operculum of *Egmundella grimaldii* Leloup, 1940 is reportedly said to be composed of many pointed, deciduous flaps ["Opercule formé de nombreuses dents pointues, caduques, prolongeant directement l'hydrothèque" (Leloup, 1940: 7)], while that of *Egmundella modesta* Millard & Bouillon, 1975 possesses "triangular segments clearly demarcated from thecal wall" (Millard & Bouillon, 1975: 5); in a previous description of their species, Millard & Bouillon (1973: 43, as ? *Lovenella* sp.) report the following: "Margin indented to take the opercular segments which are sharply demarcated from it". The operculum of *Oplorhiza diaphragmata* Naumov, 1960 consists of "10-14 narrow triangular plates sometimes folded into a many-sided pyramid over the hydrotheca mouth. No sharp boundary between hydrotheca mouth and operculum" (Naumov, 1969: 337). Reexamination of fresh specimens of these species is therefore necessary to document the exact condition of their hydrothecal opercula.

Besides *E. magellanica* sp. nov., two other congeners occur in the eastern Pacific, namely *E. gracilis* and *Egmundella polynema* Fraser, 1948. The former, originally found in the Vancouver area (Stechow, 1921), was subsequently recorded from southern Chile (Galea, 2007). It is a species with comparatively smaller hydrothecae (Table 3), characterized by the occurrence of the nematothecae not only on the hydrorhiza, but also in small groups a short distance below the thecal bases. The presence of dense clusters of nematothecae on the hydrothecal pedicels of *E. polynema*, as well as its longitudinally striated gonothecae, make it distinct from the new species described herein.

Two hydroids have been described from the western Pacific, *viz. O. diaphragmata* and *Egmundella humilis* Fraser, 1936. The former apparently displays a hydrothecal operculum with a different structure (see above), and its putative gonothecae are long and conical (Naumov, 1969). The latter is a comparatively smaller species than *E. magellanica* sp. nov. (see Table 3), and its gonothecae are sessile and provided with wrinkled walls (Hirohito, 1995).

Although *C. producta* occurs on both sides of the North Atlantic [notably its medusa, see Schuchert (2016)], five other hydroids were recorded exclusively from the western Atlantic: *Egmundella grimaldii* Leloup, 1940, *Egmundella fasciculata* Fraser, 1940, and *Egmundella grandis* Fraser, 1941 occur in cold to temperate areas, while *O. parvula* and *Egmundella superba* Stechow, 1921 are tropical (see original accounts). The morphology and taxonomic position of *C. producta* were discussed by Schuchert (2016) and Schuchert *et al*. (2017), respectively. *Egmundella grimaldii* and *E. superba* have larger hydrothecae than *E. magellanica* sp. nov. (see Table 3), *E. fasciculata* builds polysiphonic colonies (Fraser, 1940), *E. grandis* has nematothecae on both the stolon and hydrothecal pedicels (Fraser, 1941), and *O. parvula* has twisted pedicels immediately below the hydrothecal bases (Allman, 1877), a condition never met with neither in the new species, nor in some of its congeners [*e.g. E. modesta*, see Millard & Bouillon (1975)].

Finally, three additional species occur in the Indian Ocean, *viz. E. modesta*, *Egmundella valdiviae* Stechow, 1925, and *Egmundella sibogae* Billard, 1940. As noted above, the closing apparatus of *E. modesta* may be different from that met with in *E. magellanica* sp. nov., its hydrothecae are comparatively shorter (see Table 3), and its nematothecae are spherical and sessile (Millard & Bouillon, 1975). Although similar in shape, the gonothecae of *E. sibogae* are of smaller proportions (see Table 3), and this species is kept separate mainly on biogeographical grounds. Similarly, based on its geographical origin, the new species is considered as distinct from *E. valdiviae* occurring off West Sumatra.

Linking hydroids and medusae under a unified classification and nomenclature can be challenging. However, even though the life cycle of the present hydroid remains to be studied, it has been decided to create a new species for it, mainly because its morphology is different from that of its two other congeners from the eastern Pacific, *E. gracilis* and *E. polynema*. In addition, based on biogeographical grounds, it is assumed that the tropical *O. parvula*, *E. superba*, *E. modesta*, *E. valdiviae*, and *E. sibogae*, the northwestern Atlantic *E. grimaldii*, *E. fasciculata* and *E. grandis*, as well as the northwestern Pacific *O. diaphragmata* and *E. humilis* could reasonably be excluded from the comparison, besides a series of morphological differences displayed by some of them (Table 3). Moreover, Patagonian medusae are poorly known, and the dispersive stage of *E. magellanica* sp. nov. may well be undescribed.

Sampling new material of hydroids and medusae for molecular studies is required to allow sequence comparisons for matching their life cycles (*e.g.* Schuchert *et al*., 2017).

Distribution: Chile – Región de Magallanes y Antártica Chilena [Bahía Parry (present study)].

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An Afrotropic element at the north-western periphery of the Oriental Region: *Pseudomicrommata mokranica* sp. nov. (Araneae: Sparassidae)

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Abstract: The surprising discovery of a new species of grass huntsman spider, *Pseudomicrommata mokranica* sp. nov. (♂♀), belonging to "the African clade", is reported and described from south-eastern Iran, more than 4000 km away from the nearest recorded locality of the genus in Kenya. Similar vicariant occurrences of other sparassid taxa in Africa and Asia are discussed.

Keywords: Taxonomy - Iran - Baluchistan - vicariance.

INTRODUCTION

The grass huntsman spiders of the genus *Pseudomicrommata* Järvi, 1914 are medium-sized wandering spiders living in African savannah habitats. For a long time and prior to a revision by Moradmand (2015), the genus was known to be monotypic. It currently includes four species distributed in sub-Saharan Africa: *Pseudomicrommata longipes* (Bösenberg & Lenz, 1895) (Kenya, Tanzania, Botswana, South Africa, Namibia), *Pseudomicrommata mary* Moradmand, 2015 (Guinea, Ivory Coast), *Pseudomicrommata schoemanae* Moradmand, 2015 (Cameroon) and *Pseudomicrommata vittigera* (Simon, 1897a) (Namibia, South Africa) (World Spider Catalog, 2019). The phylogenetic position of *Pseudomicrommata* was recovered in the "African clade" and as the sister taxon of *Arandisa* Lawrence, 1938, which is endemic to desert-habitats of SW Africa (Moradmand *et al*., 2014). The "African clade", which apart from the two mentioned genera also includes *Carparachne* Lawrence, 1962, *Leucorchestris* Lawrence, 1962, *May* Jäger & Krehenwinkel, 2015, *Microrchestris* Lawrence, 1962 and *Palystella* Lawrence, 1928, was later supported by morphological evidence (Jäger & Krehenwinkel, 2015).

The Sparassidae of Iran are relatively well studied. To date, 18 species belonging to five genera (*Cebrennus* Simon, 1880a, *Eusparassus* Simon, 1903, *Micrommata* Latreille, 1804, *Olios* Walckenaer, 1837, *Spariolenus* Simon, 1880b) have been recorded from Iran (Zamani *et al*., 2019), 10 of which are regional endemics (Moradmand, 2017).

The Iranian plateau is located in the transition zone of three biogeographic realms, the Palearctic (northern and central parts of the plateau), the Afrotropic (south-western part) and the Oriental (south-eastern part) (Olson *et al*., 2001), and it harbours a wide variety of corresponding animal elements (Zehzad *et al*., 2002).

In this paper we report the surprising discovery of a new species of *Pseudomicrommata* from the north-western periphery of the Oriental region in south-eastern Iran (Pešić *et al*., 2012), more than 4000 km away from the nearest recorded locality of the genus in Kenya.

MATERIAL AND METHODS

The two immature specimens (male and female) were recently collected in SE Iran (Sistan & Baluchistan Province) and reared in captivity until they reached maturity. They were studied using an Echord AB-8M-220 stereomicroscope, and a Leitz Wetzlar stereomicroscope equipped with a drawing tube for the illustration of morphological characters. The description style follows that of Moradmand (2015). Measurements are given in millimetres. The size classes of specimens are according to Jäger (2001): small: 3-10, medium: 10-20. The spination pattern follows Davies (1994): sum of all spines

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(prolateral, dorsal, retrolateral, ventral), the latter is only listed if present. The distribution map was prepared using DIVA-GIS (available at: http://www.diva-gis.org/).

The abbreviations used throughout the text are: AB - anterior bands of epigynal field; ALE - anterior lateral eyes; AME - anterior median eyes; AMP - anterior margin of epigynal pocket; C - conductor; CD - copulatory duct; CO - copulatory opening; dRTA - dorsal retrolateral tibial apophysis; EA - embolic apophysis; EF - epigynal field; EP - epigynal pocket; EM - embolus membrane; ET - embolus tip; FD - fertilization duct; fTL - first turning loop; GPO - glandular pores; LL - lateral lobes; MS - median septum; PLE - posterior lateral eyes; PME - posterior median eyes; PMP - posterior margin of epigynal pocket; RTA - retrolateral tibial apophysis; sTL - second turning loop; T - tegulum; vRTA - ventral retrolateral tibial apophysis; I-IV - 1st to 4th legs.

Depository: MHNG - Muséum d'histoire naturelle, Genève, Switzerland (Peter J. Schwendinger).

TAXONOMY

Family Sparassidae Bertkau, 1872
Genus *Pseudomicrommata* Järvi, 1914

The genus is characterised by a longitudinal median stripe on the dorsum of the opisthosoma (Figs 10-11) in combination with characters of the copulatory organs: EP in females and EA in males (Figs 1-3, 6-9). For a detailed diagnosis and description of the genus see Moradmand (2015).

Pseudomicrommata mokranica sp. nov.

Figs 1-11

Type material: MHNG; male holotype; Iran, Sistan & Baluchistan Province, Sarbaz County, Jakigur, WGS84 26.12722, 61.50889; November 2017; leg. A. Zamani. – MHNG; female paratype; same data as for the holotype.

Etymology: The specific epithet is an adjective referring to the type locality, Mokran, a historical name for the strip of land along the northern coast of the Gulf of Oman in Iran and Pakistan.

Diagnosis: The male can be distinguished from those of the African congeners by the shape of the embolus (slender and elongated), by the embolic apophysis, which is slender along its entire length and generally elongated, and by the embolus tip turned prolaterad at its most distal end (other species: not turned and situated retrolaterally) (Figs 1-3). The vulva is characterized by only the outer half of the first turning loop being sclerotized whereas the inner half is hyaline (in other species the first turning loop is entirely sclerotized) (Figs 6-7).

Description of male: Habitus as in Fig. 10.

Measurements: Medium-sized sparassid; total length 11.2, carapace length 5.0, maximum width 4.2, anterior width 2.3, opisthosoma length 6.2, width 3.8.

Chelicerae: With 2 anterior and 3 posterior teeth on cheliceral furrows and no denticles between them; retromargin with one long bristle at base of fang (Fig. 5).

Eyes: Diameters: AME 0.23, ALE 0.41, PME 0.36, PLE 0.37, interdistances: AME-AME 0.17, AME-ALE 0.04, PME-PME 0.31, PME-PLE 0.26, AME-PME 0.63, ALE-PLE 0.23. Anterior and posterior eye row slightly recurved and procurved, respectively, AME smallest, remaining eyes subequal (Fig. 4).

Measurements of palp and legs: Leg formula: IV II I III. Palp 6.4 [1.7, 0.8, 2.0, 2.9], I 17.6 [4.8, 2.4, 4.5, 4.3, 1.6], II 19.2 [5.4, 2.4, 5.1, 4.7, 1.6], III 17.1 [4.8, 2.2, 4.5, 4.1, 1.5], IV 19.5 [5.3, 2.1, 5.2, 5.3, 1.6].

Spination: Palp 131, 101, 1130. Legs: femora I-II 223, III 323, IV 332; patellae I-IV 101; tibiae I-III 2126, IV 2226; metatarsi I-III 0004, IV 3036.

Palp: As described in diagnosis, with cymbium nearly 2.5 times longer than tibia; dRTA longer than vRTA; dRTA distally pointed, vRTA rounded. Embolus slender and elongated as EA but longer; E extending slightly beyond conductor and both beyond retromargin of cymbium. Conductor hyaline and long (Figs 1-3).

Description of female: Habitus as in Fig. 11.

Measurements: Total length 14.4, carapace length 5.6, maximum width 4.5, anterior width 2.8, opisthosoma length 8.7, width 4.2.

Chelicerae: As in male.

Eyes: Diameters: AME 0.25, ALE 0.44, PME 0.37, PLE 0.38, interdistances: AME-AME 0.18, AME-ALE 0.05, PME-PME 0.37, PME-PLE 0.28, AME-PME 0.76, ALE-PLE 0.41.

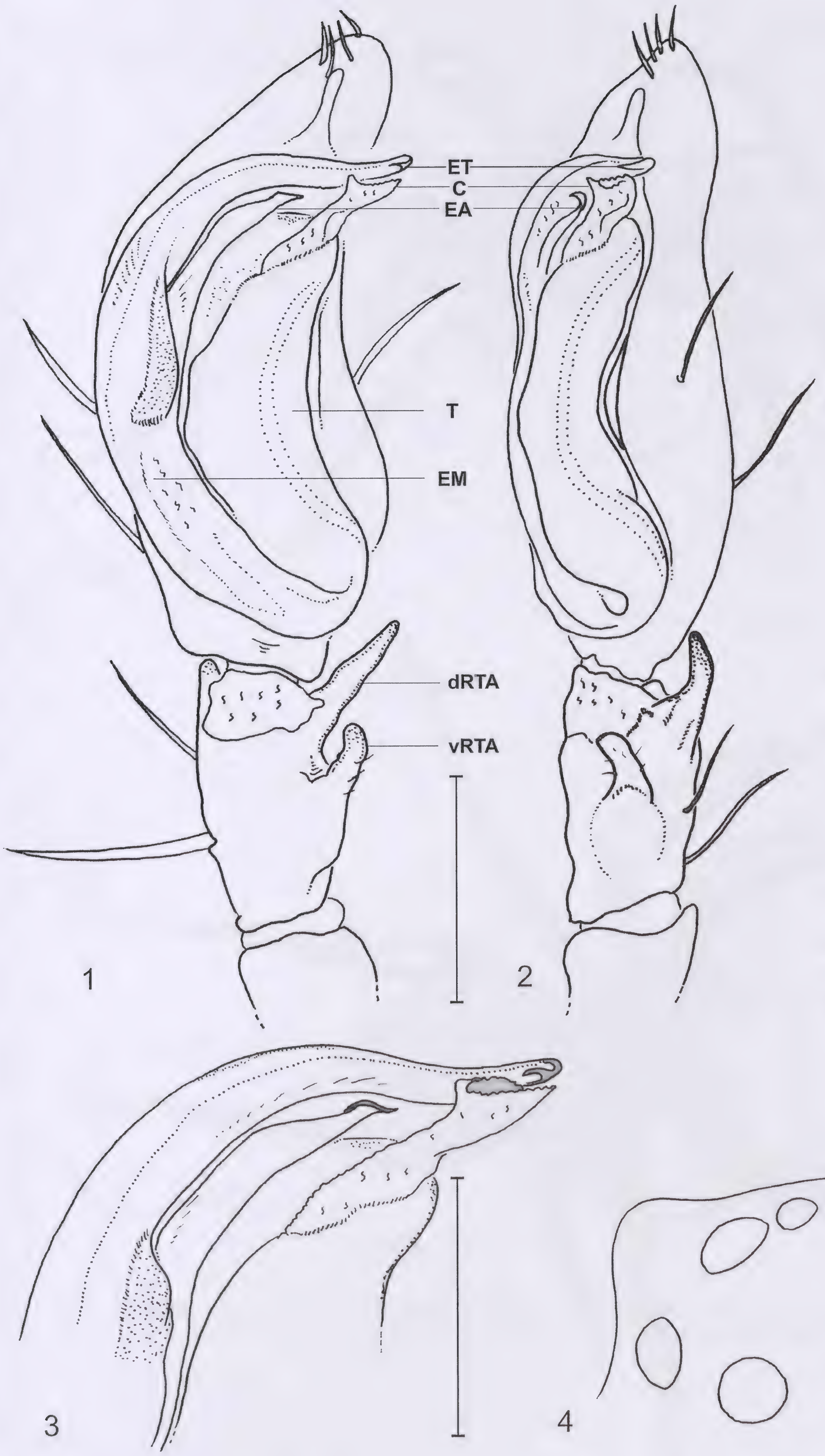
Measurements of palp and legs: Leg formula: IV II I III. Palp 6.2 [2.0, 0.8, 1.3, 2.1], I 17.0 [4.6, 2.6, 4.2, 3.9, 1.7], II 18.7 [5.7, 2.6, 4.5, 4.1, 1.8], III 16.8 [5.1, 2.3, 4.0, 3.7, 1.7], IV 19.9 [5.9, 2.5, 4.7, 5.0, 1.8].

Spination: Palp 131, 101, 2121, 1013. Legs: femora I 123, II-III 323, IV 331; patellae I-IV 000; tibiae I 1026, II-III 2026, IV 2126; metatarsi I-III 0004, IV 3036/2026.

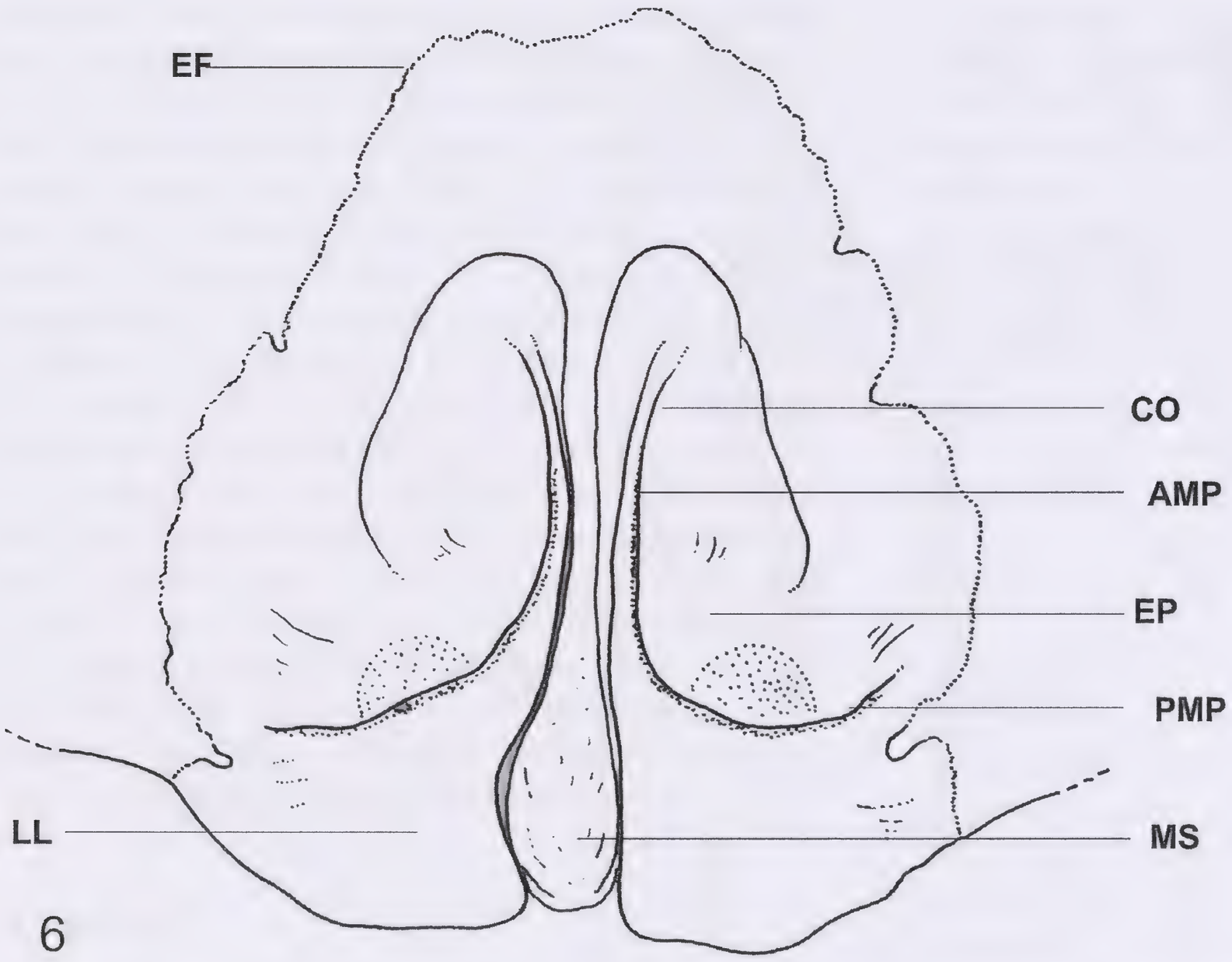
Epigyne: EF longer than wide, without anterior bands or slit sensilla. Epigynal pocket with PMP longer than AMP, MS entirely visible and hyaline; vulva GPO not visible on fTL; fTL and sTL of same size and length (Figs 6-9).

Colouration: Creamy-brown, a diagnostic dark longitudinal stripe with narrow light margins dorsally on prosoma and opisthosoma. Tarsi darker than other leg segments (Figs 10-11).

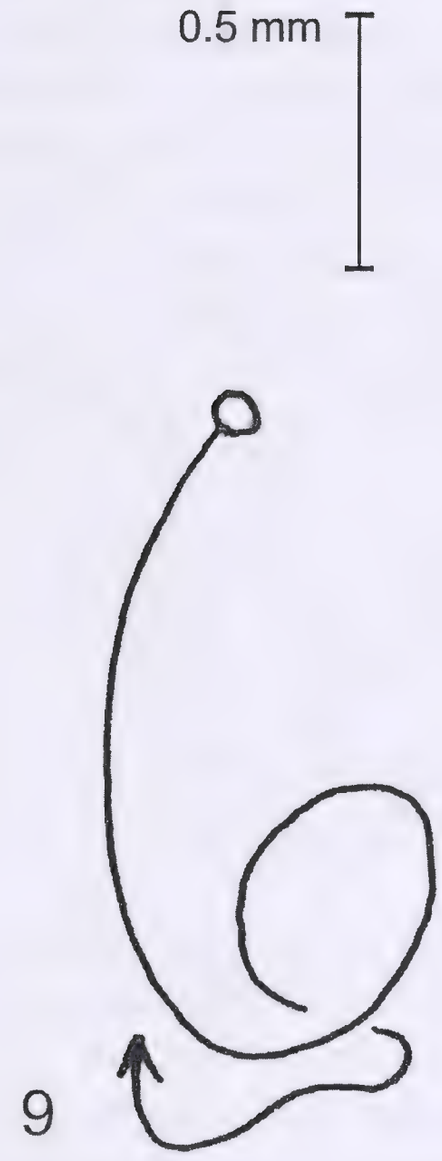
Distribution, phenology and habitat preferences: This species is known only from the type locality in SE Iran (Fig. 12). The specimens were collected by following the reflections of a flashlight in their eyes, in a dry meadow, on grass stalks. The male and female matured in mid-August and mid-September, respectively.



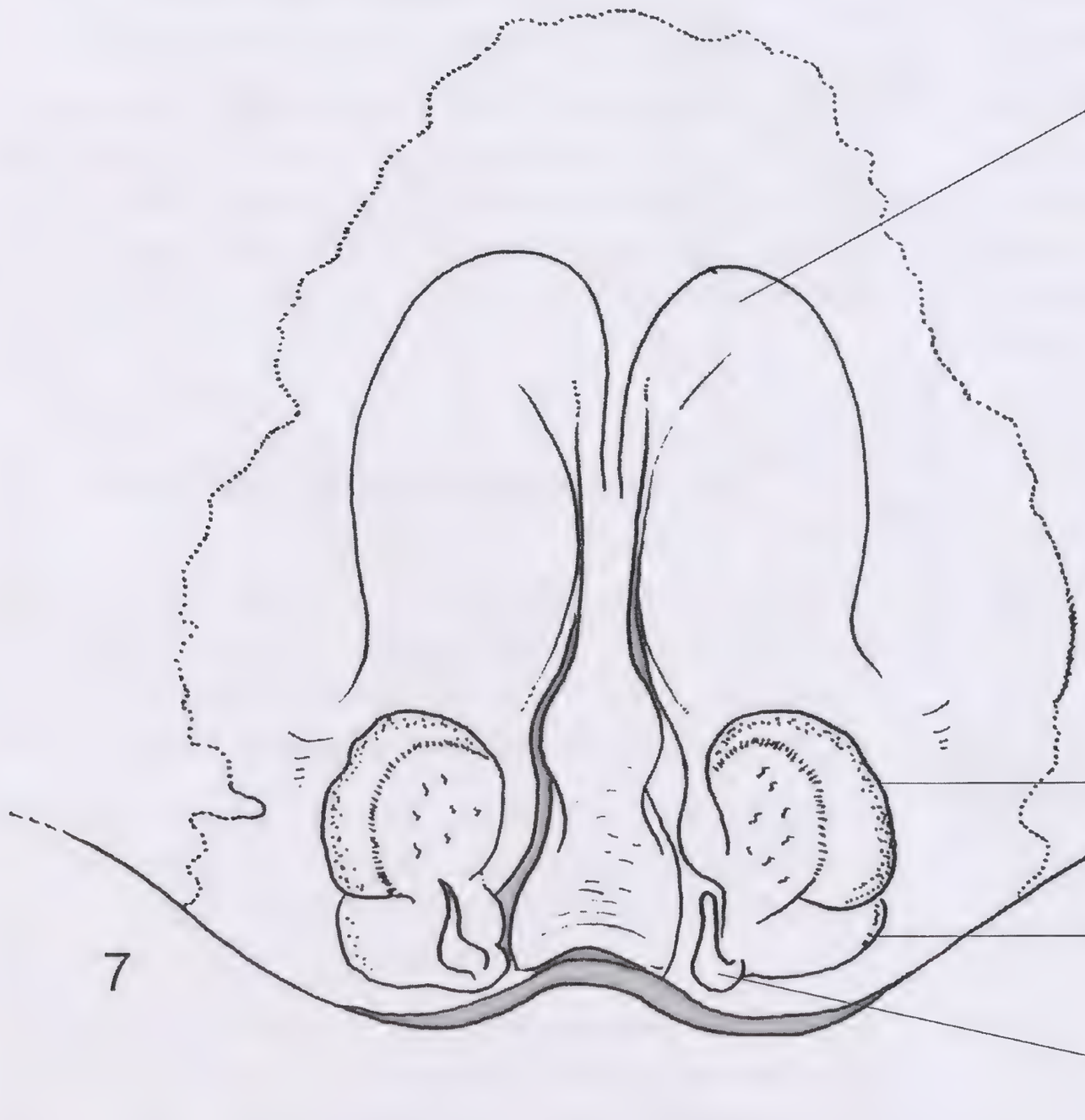
Figs 1-5. *Pseudomicrommata mokranica* sp. nov., male holotype, Iran. (1-2) Left palp, ventral and retrolateral views. (3) Distal part of tegulum, with embolus tip, embolic apophysis and conductor, ventral view. (4) Eye arrangement, dorsal view. (5) Left chelicera, ventral view. Scale bars = 1.0 mm.



6



9



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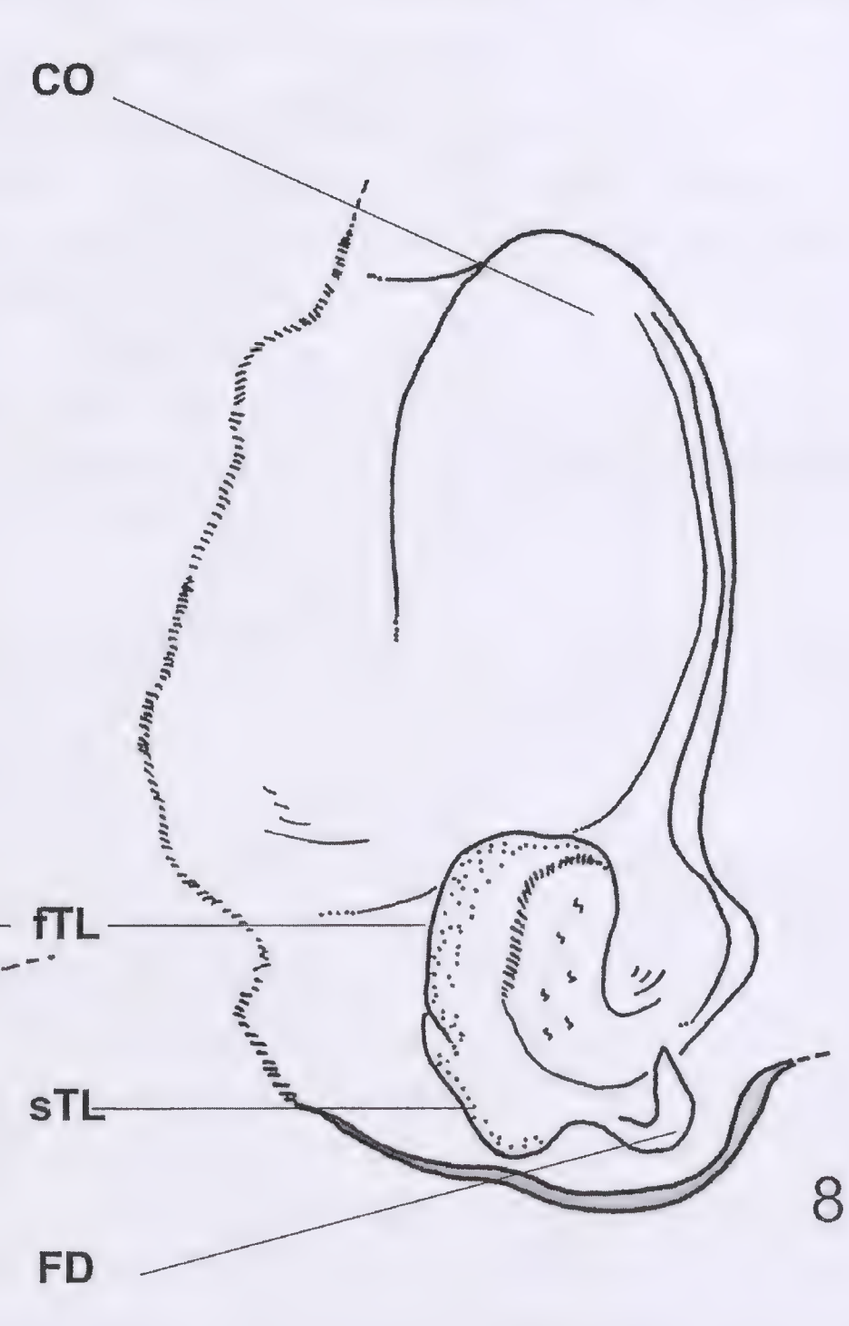

8

Figs 6-9. *Pseudomicrommata mokranica* sp. nov., female paratype, Iran. (6) Epigyne, ventral view. (7) Vulva, dorsal view. (8) Ditto, left half, lateral view. (9) Schematic course of internal duct system, ventral view. Scale bars = 0.5 mm.

10

11

Figs 10-11. *Pseudomicrommata mokranica* sp. nov., habitus of male, anterior view (10) and of female, dorsal view (11).

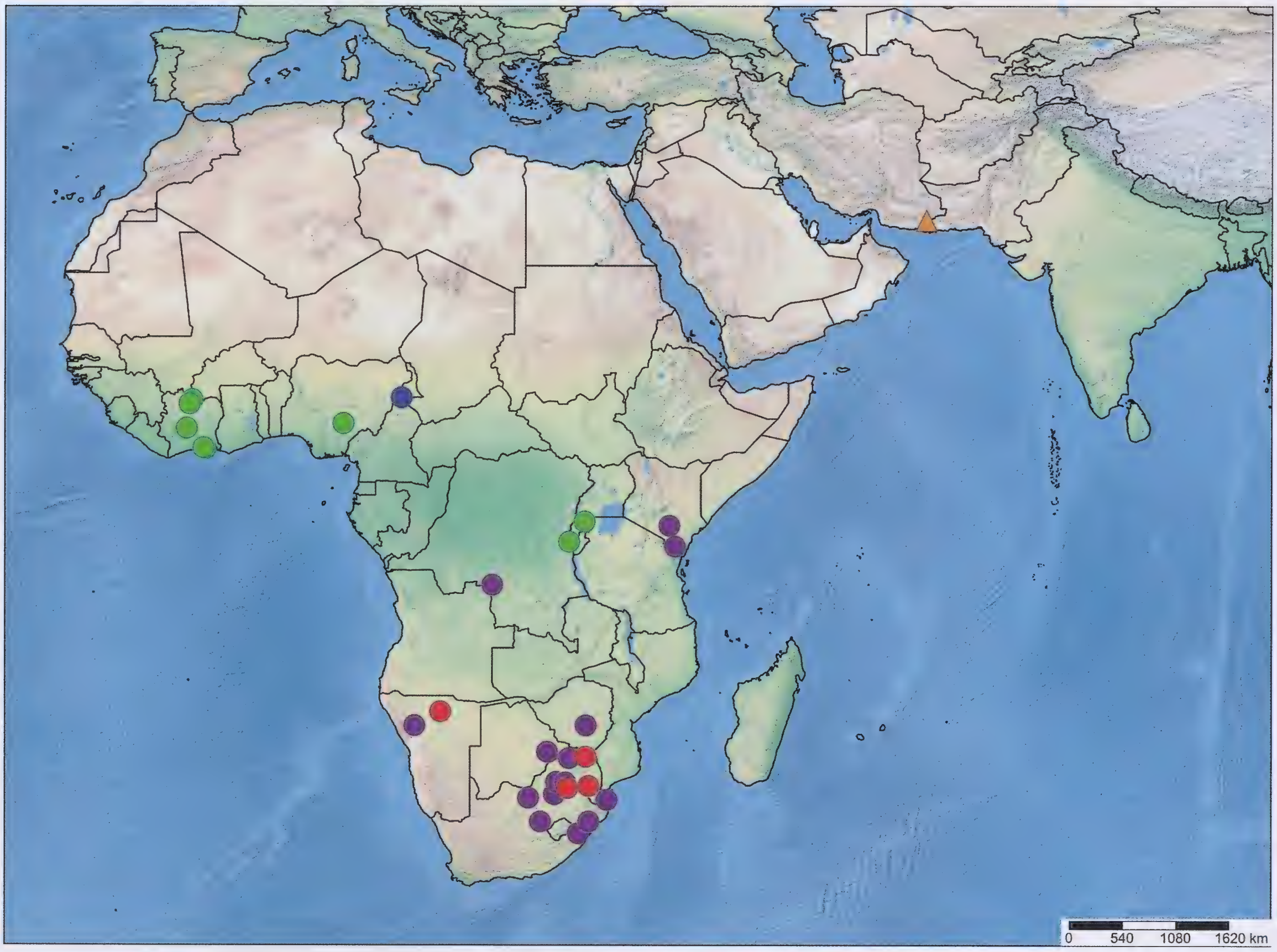

Fig. 12. Distribution map of *Pseudomicrommata* spp.: orange triangle = *P. mokranica* sp. nov.; violet circles = *P. longipes*; green circles = *P. mary*; blue circle = *P. schoemanae*; red circle = *P. vittigera*.

DISCUSSION

The discovery of a member of the predominantly African genus *Pseudomicrommata* in Iran, at the north-western periphery of the Oriental Region (Pešić *et al.*, 2012), is surprising. There are few other taxa of the family Sparassidae crossing the transition zone between Africa and Asia: *Barylestis* Simon, 1910 with ten Afrotropical species and one species in SE Asia (Thailand/Myanmar). In contrast to *Pseudomicrommata* species, *Barylestis* spiders inhabit humid forests on both continents (Jäger, 2008). The same habitats are occupied by *Gnathopalystes* Rainbow, 1899 with nine SE Asian species and one undescribed species from Tanzania (Jäger & Kunz, 2005). Other vicariant and phylogenetically very closely related taxa are the sister genera *Rhitymna* Simon, 1897b, with 19 species in tropical Asia (World Spider Catalog, 2019; Jäger, 2019), and *Remmius* Simon, 1897b, with five nominal species in tropical Africa (Moradmand *et al.*, 2014). The species-rich genus *Olios* also contains several lineages with closely related species occurring in Africa and Asia. For all the taxa listed above, humid forests seem to be the most favourable habitat. *Pseudomicrommata*, however, prefers dry savannah grasslands and meadows, although Moradmand (2015) lists also leaf litter, bushes and small trees as habitats. The characteristic colouration of the new species and the find of an egg-sac attached to grass leaves point to an overall preference to habitats with grassland.

According to the modelling of palaeoclimatic conditions by Micheels *et al.* (2007), savannah grasslands have occurred since the late Miocene (11 to 7 Mya) as a broad W-E strip of land in the central Sahara and in patches on the Arabian Peninsula. Similar results were published by Beerling & Osborne (2006) whose research suggests that C4 grassland savannahs are eight million years old. Moreover, they assume that a savannah "stepping stone" existed on the Arabian Peninsula. Furthermore, the Arabian Peninsula was connected to the southern Iranian plateau through a land bridge of savannah in the late Miocene (Shmida, 1985), which permitted the exchange of taxa between the two lands prior to the final

filling of the Persian Gulf in 18,000 ya (Lambeck, 1996). Bowman *et al*. (2009) found out that between 8 and 7 Mya fires contributed to the simultaneous expansion of tropical savannahs in Africa, Asia and the Americas due to a hotter climate and drier conditions. Considering that the potential origin of the genus *Pseudomicrommata* is 41 Mya and that radiation within the genus took place since 18 Mya (Moradmand *et al*., 2014), *P. mokranica* sp. nov. could be a relatively recent member of this lineage and could have expanded to the north-east along emerging grasslands in the Saharo-Sindian region (from Sahara through the Arabian Peninsula to SE Iran and Pakistan). Later, when the Sahara became drier, the population was isolated and left behind as a relict.

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Type specimens of Orthoptera (Insecta) described by Franz Werner deposited in the Muséum d'histoire naturelle de Genève

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Abstract: Primary type specimens of ten species described by Franz Werner have been identified in the collections of the Muséum d'histoire naturelle de Genève. These are listed alphabetically, the condition of the specimens is recorded and the valid combination is given. The status of a specimen labelled as the lectotype of an eleventh species is discussed.

Keywords: Adolf Nadig - Acrididae - Pamphigidae - Tettigonidae.

INTRODUCTION

The Austrian biologist Franz Werner (1867-1939) was a professor at the Vienna Institute of Zoology for many years and is probably best known as a herpetologist. He also studied scorpions and orthopteroid insects however, publishing more than 100 papers on the latter group, principally the Mantodea.

After Werner's death his private collection was given to the Naturhistorische Museum in Vienna by his sons, but many of the type specimens had already been sold to various European museums to help finance Werner's fieldtrips (Kaltenbach, 2003). Most of the Mantodea type specimens are deposited in the Naturhistorika Riksmuseet in Stockholm (Ehrmann, 2002), and there is some confusion about the depository of others.

The type specimens of species described by Werner found in the Muséum d'histoire naturelle de Genève (MHNG) were in the collection left to the MHNG by Adolf Nadig (Schwendinger & Lienhard, 2001). All of them are specimens collected by Nadig and his father (also called Adolf Nadig) in Morocco and described by Werner in two publications (Werner, 1932, 1933).

Werner did not designate holotypes in his descriptions, but he sometimes labelled specimens as the type and paratypes. Nadig accorded these specimens a formal status, and in some of his publications referred to Werner's labelled specimens as holotypes, but they are actually syntypes unless it is clear that Werner had only seen one specimen or a lectotype has been designated.

ARRANGMENT AND FORMAT

The species are listed alphabetically. The format for each is:

specific epithet Author, publication: page [*Original generic placement*].

Provenance as given in the original description. Type series.

Specimen: "Label data" [format of label]. Following the recommendations of Ohl & Oswald (2004) the condition of each primary type specimen is noted. Other comments. Location of material in the MHNG Orthoptera collection. Currently valid combination following Cigliano *et al.* (2015)

The following abbreviations are used in the list.

MHNG Muséum d'histoire naturelle de Genève

OSF Orthoptera Species File (Cigliano *et al.*, 2015)

CATALOGUE

atlanticus Werner, 1933: 84 [*Uromenus*].

Tizi n'Tichka, Grosser Atlas, 19.-21.7.32. Unspecified number of ♂ and ♀.

A ♂ lectotype was inadvertently designated by Nadig (1979: 137) when he referred to the specimen in his collection labelled by Werner as the "Type" as the holotype: a ♂ with labels: "Tizi n'Tichka, Maroc, 19.-21. VII.32, Ad. Nadig" [printed on white card]; "Uromenus atlanticus det. Werner Type ♂ det. Werner" [handwritten by Werner on white card with "det. Werner" printed twice]; "U. poncyi atlanticus WERNER ♂ det. Nadig"

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[typewritten on white card with "♂" handwritten and "det. Nadig" printed]; "Holo-Typus" [printed on red card with "Holo-" typewritten]; "Lectotypus" [printed on red card]. Both antennae, the tip of the femur, the tibia and the tarsi of the left front leg and the tibia and tarsi of the right hind leg are missing. Dissected genitalia are glued to a card mount supported on the original pin.
The ♀ specimen Nadig labelled as allotype has a Werner identification label with the word "paratype" handwritten on it. There are two additional ♂ and two ♀ with the same data and labelled by Nadig as paratypes which are probably not paralectotypes, because they do not have Werner's labels. Nadig collection, box 248.
Uromenus poncyi atlanticus Werner, 1933

bifidus Werner, 1932: 119-120 [*Ephippiger*].
El Hajeb, 22.VII.31. Unspecified number of ♂ and ♀.
A ♂ lectotype was inadvertently designated by Nadig (1976: 337) when he referred to a specimen in his collection as the holotype: a ♂ with labels: "El Hajeb Maroc, 22.VII.31, Ad, Nadig" [printed on white card]; "6" [printed on white card]; "Type" [handwritten on red card]; "Ephippiger bifidus Werner nov. spec. ♂" [Typewritten in red ink on white squared paper with "♂" added by hand]; "Lectotypus" [printed on red paper]. Most of the right antenna and the claws of the right hind leg are missing.
A ♂ with the same data and a red typewritten identification label is a paralectotype. There are a further seventeen ♂ and eighteen ♀ with the same data and labelled by Nadig as cotypes which may also be paralectotypes. Nadig collection, box 240.
Uromenus bifidus (Werner, 1932)

brachypterus Werner, 1932: 121 [*Stauroderus*].
Ifrane, 18.-21.VII.31. Unspecified number of ♂ and ♀.
A lectotype was inadvertently designated by Harz (1986: 337) who referred to the specimen thus labelled in Nadig's collection as the holotype: a ♂ with labels: "Ifrane Maroc, 18.-21.VII.31, Ad. Nadig" [printed on white card]; "St. brachypterus Wern. ♂ det. Wern." [handwritten by Werner on white card]; "Holo-Typus" [printed on red card with "Holo-" typewritten]; "Ch. brachypterus WE. ♂ det Werner" [photocopy of label handwritten by Nadig on white card with "det. NADIG" printed, the name being crossed out by hand]; "Lectotypus" [printed on red card]. The right middle leg and left hind leg are lost.
A ♀ with the same data and a Werner identification label is a paralectotype. There are two other ♂ and ten other ♀ with the same data but without Werner identification labels which may also be paralectotypes. Nadig collection, box 810.
Chorthippus brachypterus (Werner, 1932)

ifranensis Werner, 1932: 124 [*Nadigia*]
Ifrane, 18.-21.VII.31. Unspecified number of ♂.
One ♂ syntype with labels: "Ifrane Maroc, 18.-21-VII.31, Ad. Nadig" [printed on white card]; "NADIGIA n. gen., ifranensis Werner n. sp. ♂, Type" [two labels, the first with the identification typewritten in red on white paper with "♂" added by hand and the second with "Type" printed in red on white card with a red margin, both glued to a single piece of white card]; "Eunapiodes latipes I. Bol. V. M. Dirsh det. 1960" [handwritten on white card with "V. M. Dirsh det. 19" printed]; "det. LA GRECA" [typewritten on white card with a circular blue label glued on]. The tarsi of the left hind leg are lost. Dissected genitalia are glued to a card mount supported on the original pin. Nadig collection, box 361.
Eunapiodes ifranensis (Werner, 1932)

intermedius Werner, 1933: 79-80 [*Euryparyphes*].
Tanger, 4.6.32. Unspecified number of ♀.
One ♀ syntype with labels: "Tanger Maroc, 4.VII.32, Ad. Nadig" [printed on white card]; "3" [printed on white paper]; "Euryparyphes intermedius Wern. det. Werner, ♀ Type det. Werner" [handwritten by Werner on white card with "det. Werner" printed twice]; "Gestützt auf dieses Weibchen beschrieb WERNER, 1933, pag. 79 die n. sp. intermedius. Ist mit Eu. vaucherianus synonym. A.N." [typewritten by Nadig on white card with the initials added by hand]; "Syntypus" [printed on red paper]. The last tarsal segment of the front right and the last tarsal segment of the left hind leg are missing. Nadig collection, box 349.
A junior synonym of *Euryparyphes bolivari* (Stål, 1876)

kenitramus Werner, 1932: 123 [*Euryparyphes*].
Kenitra, 2.IV.23. One ♀.
♀ holotype with labels: "Marocco, Kenitra, 2.4.23" [printed on a square of white card]; "Euryparyphes kenitranus ♀ Werner n.sp." [typewritten in red on white card with "♀" handwritten]; "Euryparyphes vaucherianus (Sauss) LA GRECA DET." [handwritten by La Greca on white card with "LA GRECA DET." printed]; "det. LA GRECA" [typewritten on white card with a circular blue label glued on]; "Type" [handwritten by Nadig on red card]. The last tarsal segment of the right front leg, both of the middle legs, the tarsi of the left hind leg and the tibia and tarsi of the right hind leg are missing. The right hind femur is detached and glued to a card mount secured on the original pin. The specimen, especially its abdomen, is laterally compressed. A label in the insect box states that the specimen was collected by Anton Schulthess, a Swiss entomologist and friend of Adolf Nadig. Nadig collection, box 349.
A junior synonym of *Euryparyphes bolivari* (Stål, 1876)

nadigiorum Werner, 1932: 116-118 [*Pteroleptis*].
El Hajeb. 22.VII.31. One ♀.
♀ holotype with labels: "El Hajeb Maroc, 22.VII.31, Ad. Nadig" [printed on white card]; "Pt. nadigiorum Werner, ♀ det. Werner" [handwritten by Werner on white card with "det. Ad. Nadig" printed, the name being crossed

out by hand]; "Type" [handwritten on red card]; "Me. seniae Finot ♀ det. Nadig" [handwritten on white card with "det. Nadig" printed]; "Holotypus" [printed on red card]. The claws of the left front leg are lost.
There are one ♂ and two ♀ with the same data, and six ♂ and eight ♀ from the same locality but collected in 1932 which are labelled as cotypes. However, the original description is explicitly based on one ♀ and so these specimens are not part of the type series. Nadig collection, box 127.
A junior synonym of *Incertana decorata* (Fieber, 1853)

peraffinis Werner, 1933: 85-86 [*Uromenus*].
Casablanca, 5.7.32. Unspecified number of ♂ and ♀.
A lectotype was inadvertently designated by Nadig (1994: 962) when he referred to the ♂ specimen in his collection as the holotype: a ♂ with labels: "Casablanca Maroc, 5:VII.32, Ad. Nadig" [printed on white card]; "Uromenus peraffinis det. Werner Type ♂ det. Werner" [handwritten by Werner on white card with "det. Werner" printed twice]; "U. peraffinis Wern. ♂ det. Nadig" [handwritten by Nadig on white card with "det. Nadig" printed]; "MA Casabl. 1932: No. 1 (M) peraffinis HOLOTYPUS MIKROF. 92:II: 10, 12, 35 und MIKROF. 92/VIII: 13, 14, 16, 20-23. Fotos und ZEICHn. Abd. Ende versch. Lage" [typewritten on yellow paper]; "Holo-Typus" [printed on red card with "Holo-" typewritten]; "Lectotypus" [printed on red card]. The last tarsal segment of the left front leg, two tarsal segments of the right front leg, the last tarsal segment of the right middle leg and the tarsi of both hind legs are missing. The hind legs have been reattached with glue.
There are four ♀ specimens with the same data labelled as allotype and paratypes by Nadig. Two of these have Werner's identification labels and are clearly paralectotypes, the other two do not have Werner labels and were probably not studied by him as part of the type series. Images on OSF. Nadig collection, box 247.
Uromenus peraffinis Werner, 1933

robustus Werner, 1933: 85 [*Uromenus*].
El Haieb, 22.7.32. Unspecified number of ♂ and ♀.
A ♂ lectotype was inadvertently designated by Nadig (1994: 993) when he referred to a specimen in his collection as the holotype: a ♂ with labels: "El Hajeb Maroc, 22.VII.32, Ad. Nadig" [printed on white card]; "Uromenus robustus det. Werner Type ♂ det. Werner" [handwritten by Werner on white card with "det. Werner" printed twice]; "U. robustus Werner ♂ det. Nadig" [handwritten by Nadig on white card with "det. Nadig" printed]; "MIKROFO. 92:III Pronot.v.oben + Zeichn cercus" [typewritten in red on yellow paper, with "+ Zeichn cercus" handwritten in pencil]; "Holo-Typus" [printed on red card with "Holo-" typewritten]; "Lectotypus" [printed on red card]. The last tarsal segment of the left front leg, two tarsal segments of the right front leg, the claws of the right middle leg, the last tarsal segment of the left hind leg and the entire right hind leg are lost. The abdomen has been eviscerated and stuffed, and is coming apart from the thorax.
A ♀ specimen with the same data and a Werner identification label is a paralectotype. Nadig collection, box 251.
Uromenus robustus Werner, 1933

septentrionalis Werner, 1931: 202-203 [*Euryparphyes*].
Bou Kellal; Dar Kaid Medboch. More than one ♀.
The MHNG collection includes a ♂ specimen with labels: "Marocco, Meknès, 28.3.23" [printed on white card]; "Euparphyes septentrionalis Wern. ♂" [handwritten by Werner on white card]; "Euparyphyes septentrionalis Werner LA GRECA DET." [handwritten by La Greca on white card with "LA GRECA DET." printed]; "Lectotypus" [handwritten by La Greca on red card]; "det. LA GRECA" [typewritten on white card, with a circular blue label glued on]. This specimen is clearly not part of the type series and therefore cannot be the lectotype. La Greca (1993: 319) states erroneously that this specimen is in the NHMW, and designates it as a "neoallotype" (an unrecognized category) rather than a lectotype. Nadig collection, box 350.
A junior synonym *of Euparyphyes laetus* (Bolívar, 1907)

validus Werner, 1932: 118-119 [*Ephippiger*].
El Hajeb, 22.VII.31. Unspecified number of ♂.
A ♂ lectotype was inadvertently designated by Nadig (1976: 335) when he referred to a specimen in his collection as the holotype: a ♂ with labels: "El Hajeb Maroc, 22.VII.31, Ad. Nadig" [printed on white card]; "5" [typewritten on white card]; "Type" [handwritten by Nadig on red card]; "Ephippiger validus Werner n. sp. ♂" [typewritten in red ink on squared paper with "♂" added in black ink by hand]; "Lectotypus" [printed on red card]. The claws of the right front leg, the tarsi of the right hind leg and the entire left hind leg are lost. The abdomen has been eviscerated and stuffed, the legs have been repaired with glue and there is insect feeding damage to the right hind tibia.
There are two ♂ paralectotypes, but the allotype and other paratypes referred to by Nadig, which are labelled as cotypes, were collected in 1932 and are therefore not part of the type series. Nadig collection, box 237.
Sabaterpia valida (Werner, 1932)

Descamps & Mounassif (1972: 276) state that the ♀ holotype of *Acinipe tubericollis* Werner, 1932 is in Nadig's collection, but the specimen is not present in the MHNG. A note in Nadig's handwriting pinned in the insect box questions whether the specimen was returned by Descamps. OSF states that the holotype is in the Natural History Museum in London, but it does not appear on their online database and the current whereabouts of the specimen is unknown.

ACKNOWLEDGEMENTS

Thanks are due to Anita Hollier, Peter Schwendinger and Bernhard Merz for comments on the layout and text, and to Bernd Hauser for historical information about the MHNG collection. Harald Bruckner (Naturhistorische Museum Wien) provided information about specimens held in Vienna.

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Contribution to the study of the genus *Centromerus* in Turkey, with the description of a new species of blind spiders (Arachnida, Araneae: Linyphiidae)

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Abstract: *Centromerus petrovi* sp. nov. (male and female) is described and illustrated from a cave in the Strandzha Mountain, Turkey (European part). The new species is closely related to C*entromerus milleri* Deltshev, 1974, known from caves of the Rhodope Mountains, southern Bulgaria, from the Ruj Mountain, western Bulgaria and from eastern Rhodope Mountains, Greece. A new synonymy is established: *Centromerus turcicus* Wunderlich, 1995, syn. nov. = *Centromerus valkanovi* Deltshev, 1983.

Keywords: Taxonomy - Turkey - Strandzha Mountain - caves.

INTRODUCTION

Currently, the genus *Centromerus* Dahl, 1886 includes 88 valid species (World Spider Catalog, 2019). Most of them (61 species) are known from Europe, only seven species are presently recorded from Turkey. In this paper *Centromerus petrovi* sp. nov. is described and illustrated from Strandzha Mountain (European part of Turkey). The new species is troglobitic and has already been reported from its type locality under *Centromerus milleri* (misidentification) by Deltshev *et al.* (2011). Therefore *Centromerus milleri* should be excluded from the list of spider species recorded from Turkey. Also, *Centromerus turcicus* Wunderlich, 1995 is newly established as a junior synonym of *Centromerus valkanovi* Deltshev, 1983. Therefore the number of *Centromerus* species currently known from Turkey is six. The diversity of the genus is much lower than in the Balkan Peninsula (27 species). The most reasonable explanation for this is that the Balkan Peninsula is better studied, and many more *Centromerus* species can be expected to be discovered in Turkey in the future.

MATERIAL AND METHODS

The specimens were collected by hand. Coloration is described from material preserved in 80% alcohol. Male palps were examined and illustrated after they were dissected from the spider bodies. Photos were taken with a Canon EOS1100D digital camera attached to an Amplival microscope. Measurements of the legs were taken from the dorsal side. Total length of the body includes the chelicerae. All measurements used in the description are in millimetres.

Abbreviations: BPS - basal part of scape (= proscape); DPS - distal part of scape; E - embolus; LC - lamella characteristica; MM - median membrane; ST - stretcher; SA - suprategular apophysis; TA - terminal apophysis.

The holotype and six females paratypes are deposited in the collection of the National Museum of Natural History, Sofia, Bulgaria (NMNHS); 1 male and 1 female paratypes are deposited in the Muséum d'histoire naturelle de Genève, Switzerland (MHNG). Type material of *Centromerus turcicus* was obtained from the Natur-Museum Senckenberg, Frankfurt, Germany (NMSF).

TAXONOMIC PART

Centromerus petrovi sp. nov.

Figs 1-3, 7-9, 13-14, 17-19

Centromerus milleri Deltshev, 1974. – Deltshev *et al.*, 2011: 42. [misidentification]

Type material: NMNHS and MHNG; male holotype, 1 male paratype, 7 females paratypes; TURKEY, European part, Strandzha Mountains, Dupnisa Cave (41.84578, 27.55997; alt. 348 m), under stones and on

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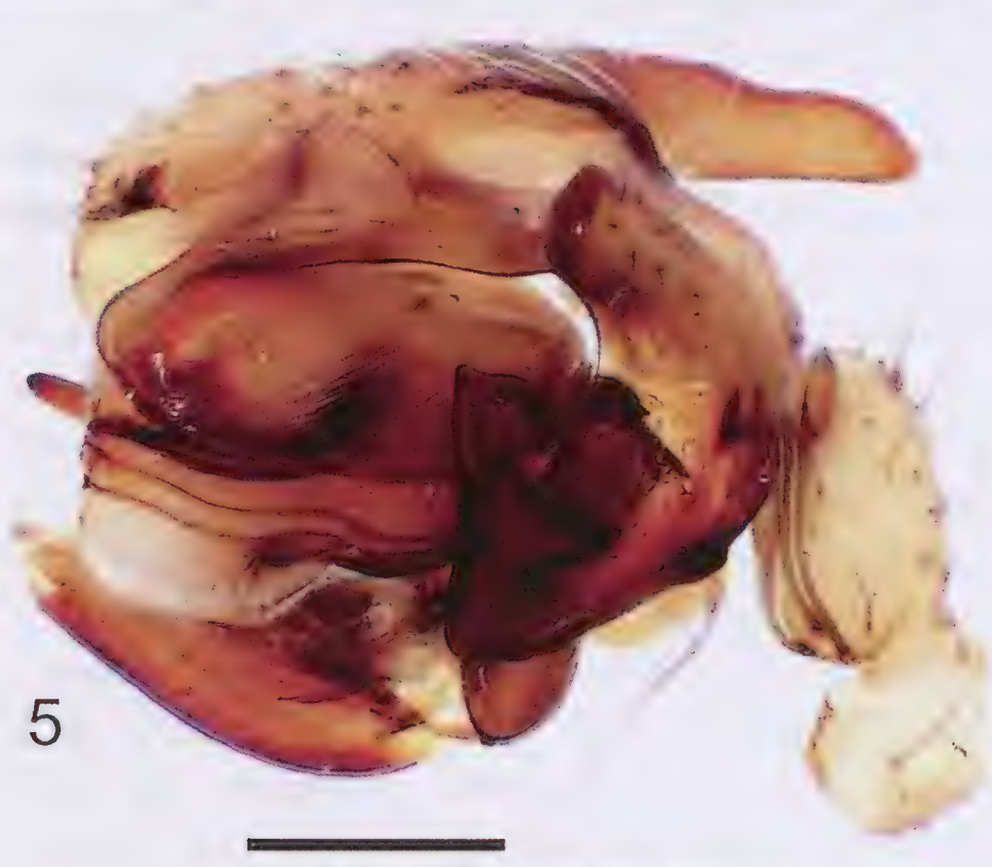
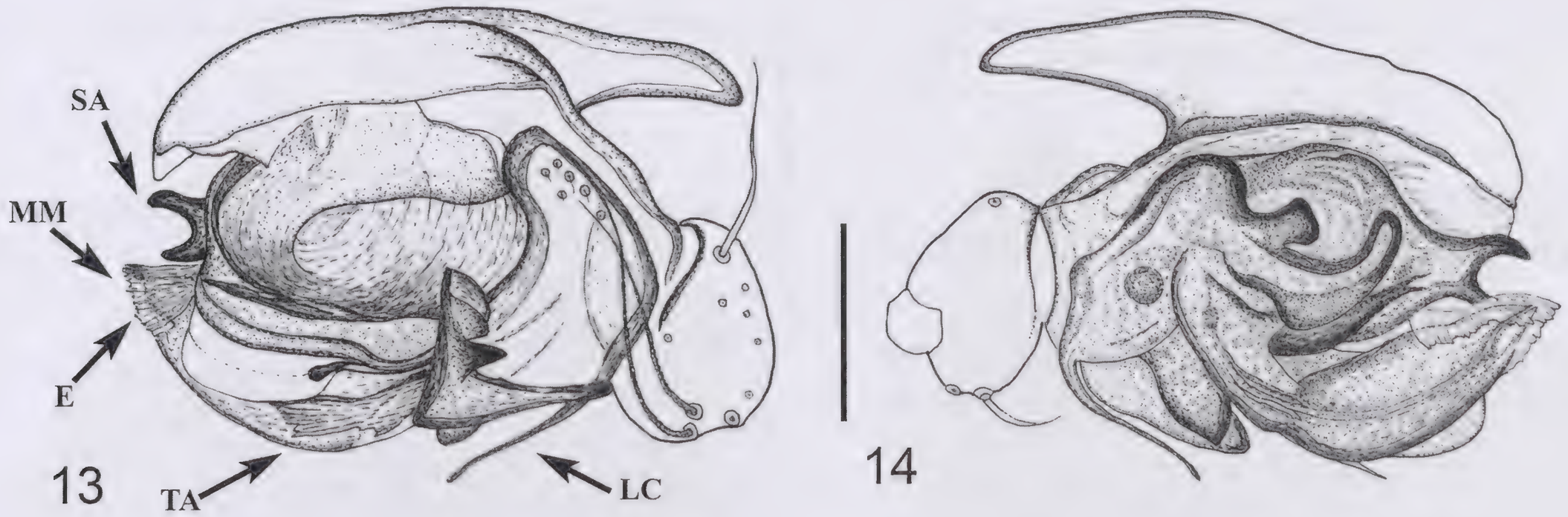
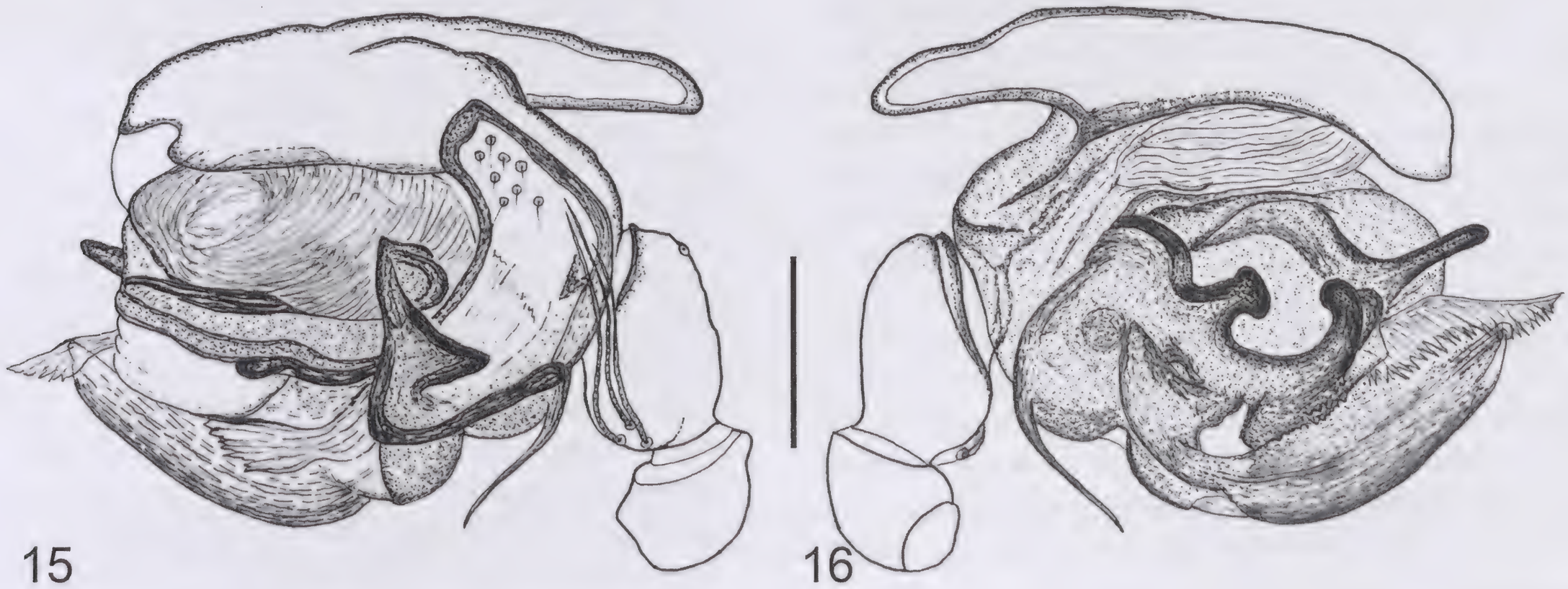


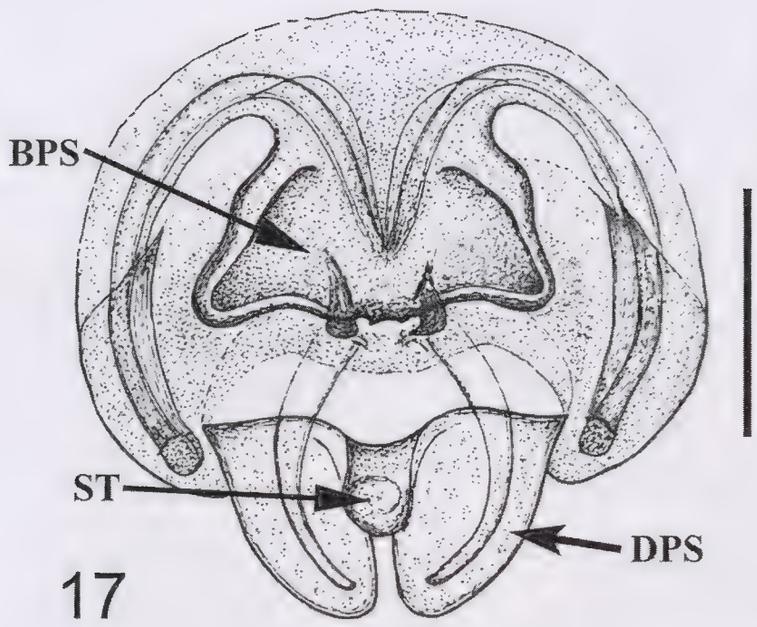
Figs 1-6. *Centromerus petrovi* sp. nov., male holotype (1-3); *Centromerus milleri*, male holotype (4-6). (1, 4) Habitus, dorsal view. (2, 5) Palp, retrolateral view. (3, 6) Palp, prolateral view. Scale: 0.8 mm (1, 4), 0.25 mm (2-3, 5-6).

Figs 7-12. *Centromerus petrovi* sp. nov., female paratype (7-9); *Centromerus milleri*, female paratype (10-12). (7, 10) Epygine, ventral view. (8, 11) Epygine, dorsal view. (9, 12) Epygine, lateral view. Scale: 0.25 mm.





Figs 13-16. *Centromerus petrovi* sp. nov., male holotype (13-14); *Centromerus milleri*, male holotype (15-16). (13, 15) Palp, retrolateral view. (14, 16) Palp, prolateral view. Scale: 0.25 mm.



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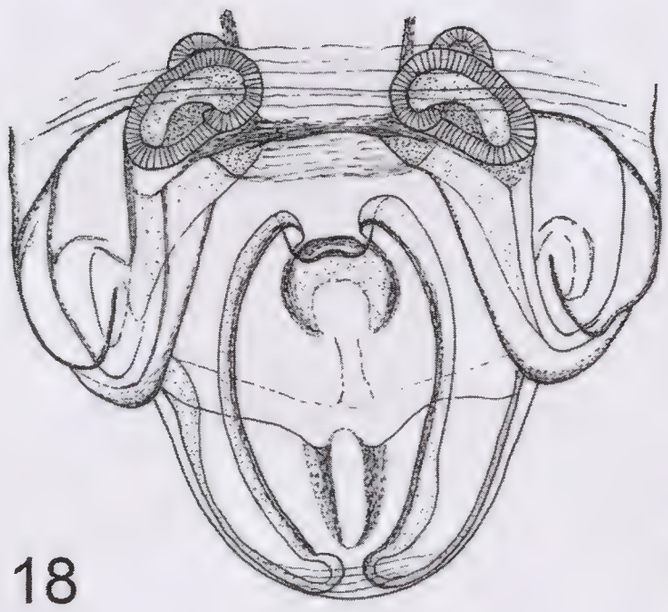

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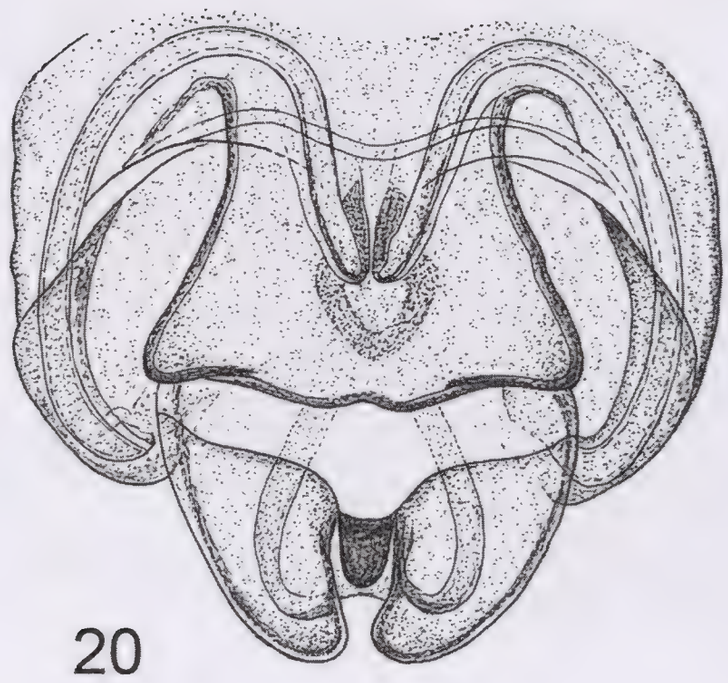

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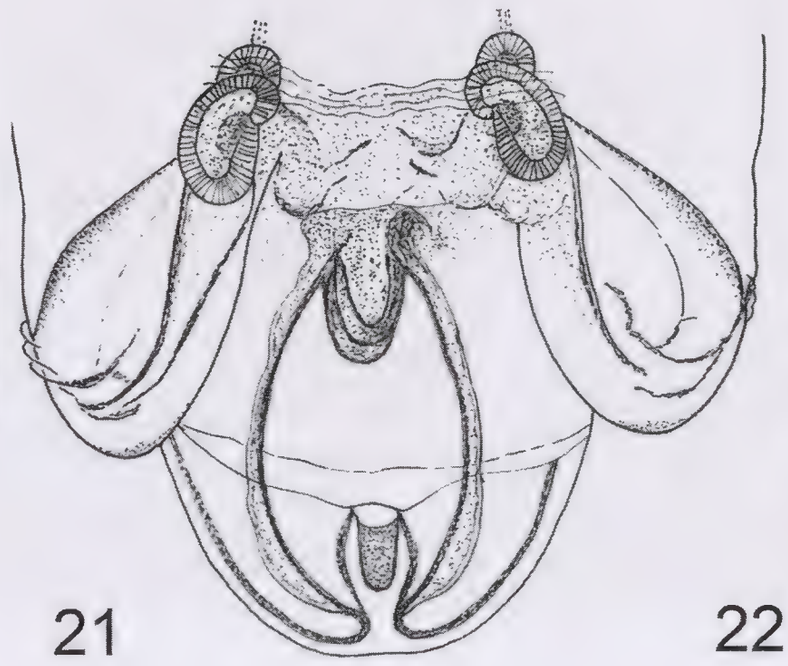

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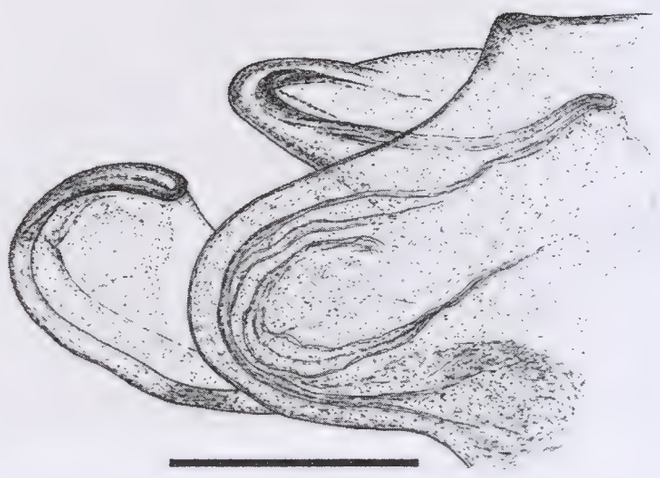

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Figs 17-22. *Centromerus petrovi* sp. nov., female paratype (17-19); *Centromerus milleri*, female paratype (20-22). (17, 20) Epygine, ventral view. (18, 21) Epygine, dorsal view. (19, 22) Epygine, lateral view. Scale: 0.25 mm.

cave walls; 25.07.2006; leg. P. Stoev & S. Lazarov. – 1 female paratype; same locality; 16.03.2008; leg. Boyan Petrov.

Diagnosis: The new species has somatic characters that correspond well to those of the genus *Centromerus*. It bears a close resemblance to *C. milleri* (Figs 4-6, 10-12, 15-16, 20-22), but can be easily distinguished by the absence of eyes and by smaller body size (Fig. 1). The male of *C. petrovi* sp. nov. can be distinguished from that of *C. milleri* also by the palp structure: the characteristic tooth on the distal part of the paracymbium is smaller and sharper than in *C. milleri* (Figs 2, 13), and the suprategular apophysis is forked (Figs 2-3, 13-14). The epigynes of both species are very similar, but in *C. petrovi* sp. nov. the basal part of the scape is narrower than in *C. milleri*, and the inner sides of the lateral lobes are parallel to each other (Figs 7, 17), whereas in *C. milleri* they are more converging distally, forming a triangle (Figs 10, 20). Moreover, the reduced stretcher in the distal part of the scape is shaped as a spherical button in *C. petrovi* sp. nov. (Figs 7, 17), while in *C. milleri* it is more elongated (Figs 10, 20).

Etymology: This species is dedicated to our late colleague and well-known Bulgarian biospeleologist and alpinist Boyan Petrov.

Description of male (holotype): Measurements: Total length 2.52; carapace length 1.08, width 0.90; chelicerae length 0.61, width 0.22; sternum length 0.72, width 0.65; abdomen length 1.51; leg I length 5.33 (1.44 + 0.32 + 1.55 + 1.30 + 0.72); leg II length 5.03 (1.33 + 0.32 + 1.44 + 1.26 + 0.68); leg III length 4.35 (1.26 + 0.32 + 1.15 + 1.08 + 0.54); leg IV length 5.61 (1.51 + 0.32 + 1.62 + 1.44 + 0.72). Coloration (Fig. 1): Carapace, sternum and legs pale yellow. Abdomen white to light grey. Male palpal cymbium and female epigyne light brown.

Eyes: Absent, only two small, hardly visible spots in place of anterior median eyes (Fig. 1).

Chelicerae: Anterior margin of groove with 4 well-developed teeth. Posterior margin with 4 very small teeth.

Legs: Femur I with 1 retrolateral spine in apical half and 1 dorsal spine in the middle. All tibiae with 2 dorsal spines.

Palp (Figs 2-3, 13-14): Tibia with 4 stout retrolateral spines. Cymbium with a long postero-dorsal protuberance. Paracymbium large and prominent, with characteristic triangular tooth on its distal part. Suprategular apophysis wide at base and forked apically. Terminal apophysis lamellar. Embolus masive, bulging. Lamella characteristica long, ending in very thin whip-like process.

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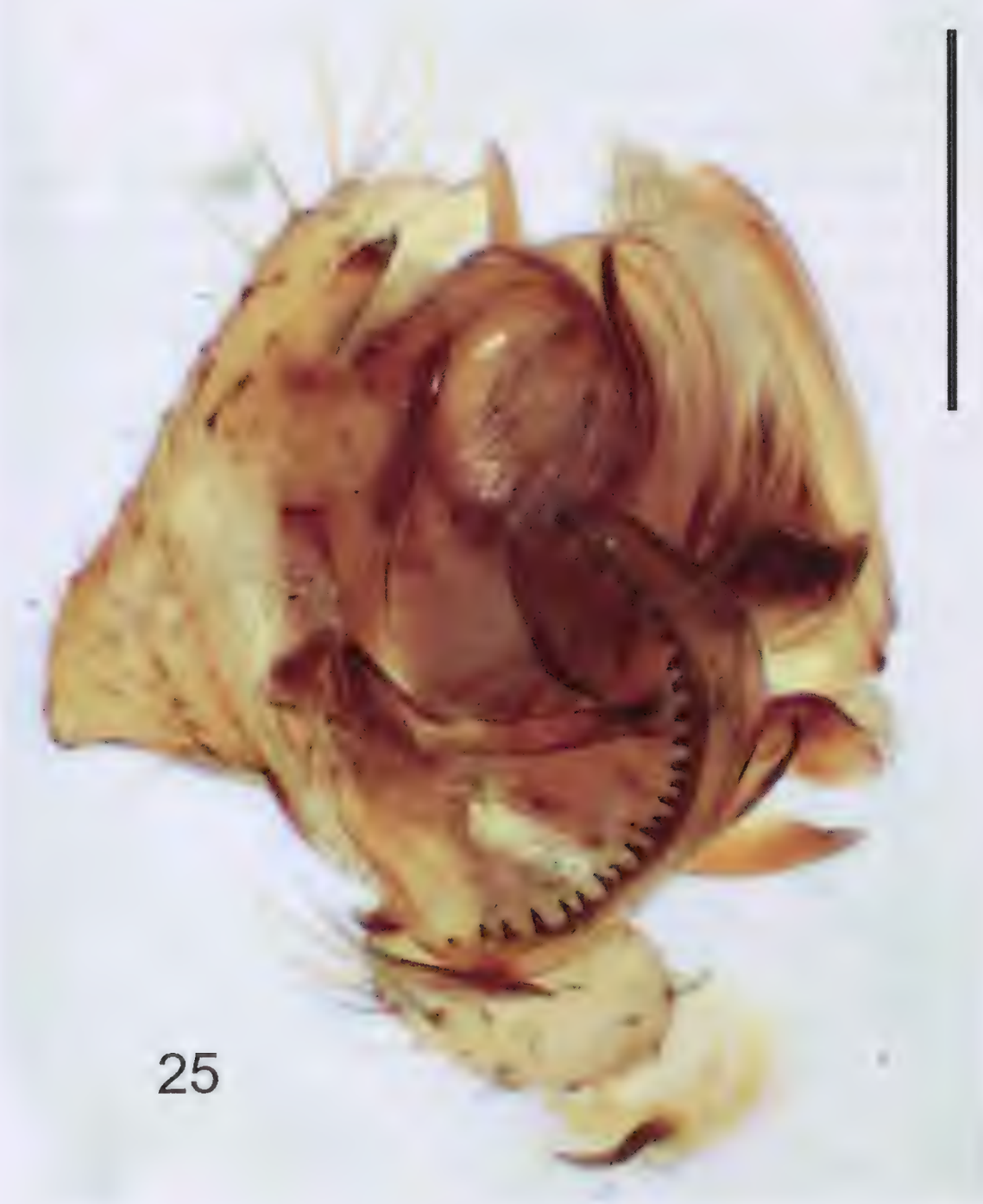

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Figs 23-26. *Centromerus valkanovi*, male holotype (23-24); *C. valkanovi*, male paratype of *C. turcicus* syn. nov. (25-26). (23, 25) Palp, retrolateral view. (24, 26) Palp, prolateral view. Scale: 0.2 mm.

Description of female paratype (NMNHS): Measurements: Total length 2.81; carapace length 1.08, width 0.72; chelicerae length 0.54, width 0.22; sternum length 0.61, width 0.54; abdomen length 2.09; leg I length 5.14 (1.44 + 0.32 + 1.44 + 1.26 + 0.68); leg II length 4.83 (1.28 + 0.32 + 1.33 + 1.22 + 0.68); leg III length 4.57 (1.33 + 0.32 + 1.26 + 1.08 + 0.58); leg IV length 5.36 (1.44 + 0.32 + 1.55 + 1.37 + 0.68). Coloration and leg spination as in male.

Epigyne (Figs 7-9, 17-19): Oval in shape. Basal part of scape trapezoid, narrow at base, gradually widening towards tip. Distal part of scape expanded, bursae copulatrix well developed.

Distribution: Known only from the type locality in the European part of Turkey.

Remarks: This species was already recorded from Turkey under *C. milleri* by Deltshev *et al.* (2011). These authors discussed that the population from the Turkish Strandzha might belong to a new troglobitic species, closely related to *C. milleri*. This assumption was confirmed when re-examining the material. Therefore *C. milleri* should be excluded from the list of the spider species known from Turkey.

Centromerus valkanovi Deltshev, 1983

Figs 23-28

Centromerus valkanovi Deltshev, 1983: 53, pl. 1, figs 1-2, pl. 2 figs 1-2. – Demircan & Topçu, 2015: 178, fig. 2A-C. – Komnenov *et al.*, 2016: 27, figs 57-58.

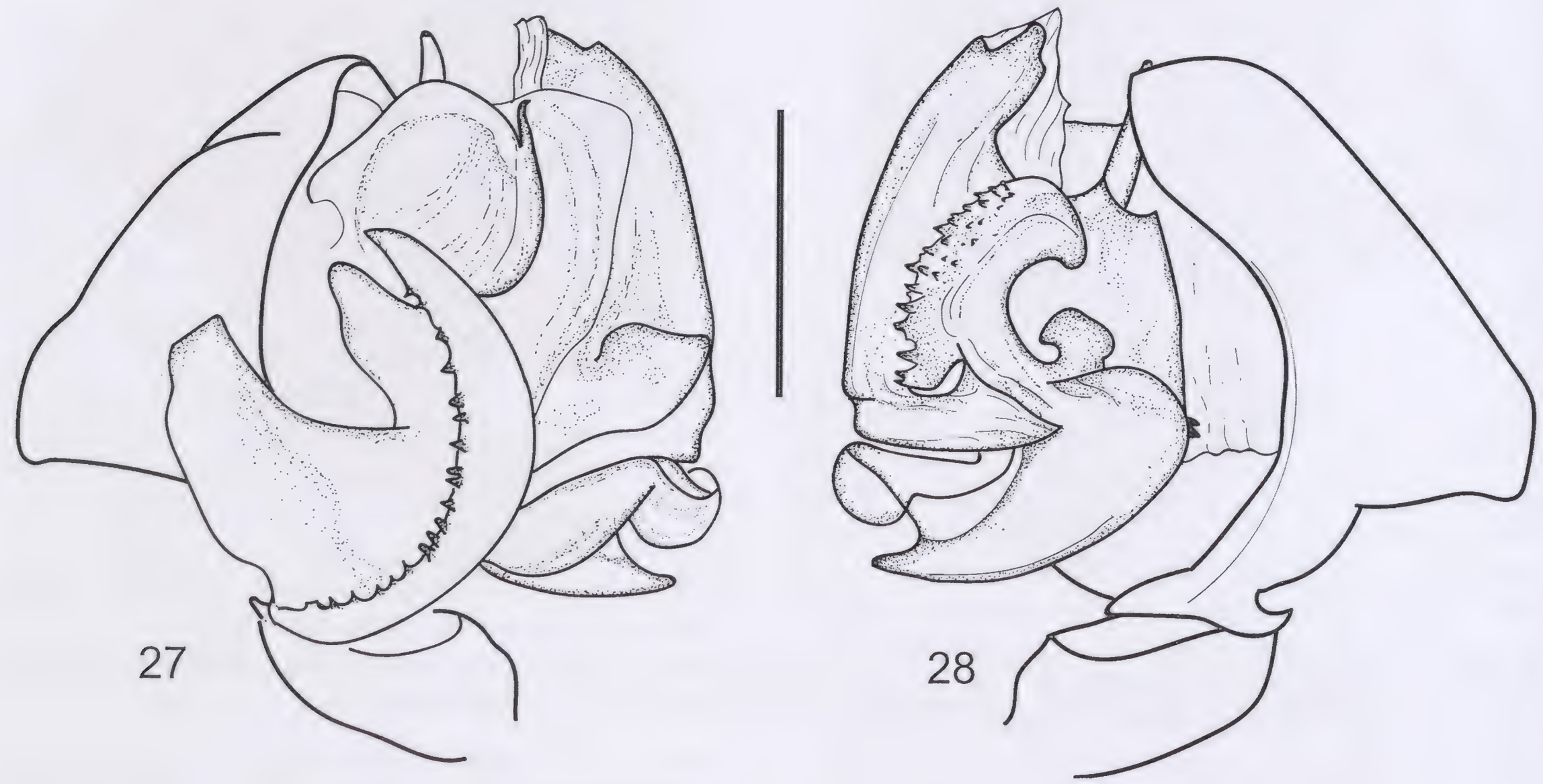
Centromerus turcicus Wunderlich, 1995: 656, figs 6-8. **syn. nov.**

Type material examined: Male holotype; NMNHS; Bulgaria, Varna, Asparuhovo; 8.09.1945; leg. A. Valkanov.

Other material examinded: Paratypes of *Centromerus turcicus*; NMSF; 5 males; TURKEY, Anatolia, Abant Mountain, near Bolu, alt. 1200 m; without date; leg. H. Korge.

Distribution: Known from several localities in Bulgaria, Greece and Turkey.

Remarks: This species was described from Bulgaria by Deltshev (1983), and recorded subsequently from the European part of Turkey (Demircan & Topçu, 2015) and from the Dadia National Park in northern Greece (Komnenov *et al.*, 2016). Wunderlich (1995) described *C. turcicus* from near Bolu, Turkey. The pictures in Wunderlich (1995) show no differences from *C. valkanovi* and the author did not discuss the relationships of the two species, which prompted us to study the type material. When comparing the paratypes of *C. turcicus* syn. nov. (Figs 25-26) to the holotype of *C. valkanovi* (Figs 23-24, 27-28), we established with certainly that they are all conspecific and that *C. turcicus* should be synonymized with *C. valkanovi*. This extends the distribution range of the species and changes its zoogeographical status. It can no longer be considered a Balkan endemic, since it is already known from the Asia Minor. It is most likely a species with an Euxinic origin. The Euxinic fauna comprises mesophilic, forest-dwelling species with a zoogeographical centre along the southern and eastern (i.e. Anatolian) Black Sea shores (Gruev & Kouzmanov,



Figs 27-28. *Centromerus valkanovi*, male holotype. (27) Palp, retrolateral view. (28) Palp, prolateral view. Scale: 0.2 mm.

1994). The fact that all records are from forest habitats supports this assumption too. The species is probably even more widespread in the east, in the Pontic montane forests.

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We are much obliged to Pavel Stoev and Stoyan Lazarov (National Museum of Natural History, Sofia) who provided spider material from Turkey. Special thanks go to Peter Jaeger (Senckenberg Museum) for sending type material of *C. turcicus* syn. nov. and to Andrei Tanasevitch (RAS, Moscow, Russia) for reviewing the manuscript. This project was partially supported by the Bulgarian Ministry of Education and Science under the National Research Program "Young scientists and postdoctoral students" approved by DCM # 577/17.08.2018, and by the projects "Cybertaxonomic approach to phylogenetic studies of model invertebrate genera (Invertebrata, Arachnida, Insecta), clarifying the problems of origin, formation and conservation of the invertebrate fauna of the Balkan Peninsula" (National Science Fund, Ministry of Education, Youth and Science of the Republic of Bulgaria, Grant KP-06-H21/1-17.12.2018).

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Hypogastrura arnei (Collembola, Hypogastruridae), a remarkable new species from the Appalachians (USA)

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Abstract: *Hypogastrura arnei* sp. nov. is described from the USA. This species has a unique combination of morphological characters: an oval and slightly flattened body, a coarse tegumental granulation, a plurichaetotic dorsal chaetotaxy, antennal segment IV with 4-6 lateral sensilla and 1 dorsal cylindrical sensillum, a moderately modified furca and minute anal spines without papilla. The new species is closely related to *H. iwamurai* Yosii, 1960, *H. reticulata* Börner, 1909 and several members of the *nivicola* (= *socialis*), *packardi* (= *sahlbergi*) and *crassaegranulata* groups sensu Christiansen & Bellinger (1980), Babenko *et al.* (1994) and Skarżyński (2009).

Keywords: Springtails - taxonomy - North America - Nearctic.

INTRODUCTION

Hypogastrura Bourlet, 1839, comprising 170 species (Bellinger *et al.,* 2019), is the largest collembolan genus within the family Hypogastruridae. Although the genus is considered cosmopolitan, the vast majority of species lives in the temperate climatic zone of the northern hemisphere. At present, about one hundred species are known in the Palaearctic (Babenko *et al.*, 1994; Thibaud *et al.*, 2004; Babenko & Fjellberg, 2006; Skarżyński, 2006a, b, 2009, 2010, 2011; Fanciulli & Dallai, 2008; Jiang & Chen, 2008; Skarżyński & Kaprus, 2009; Jiang & Yin, 2010, 2012; Skarżyński & Babenko, 2009; Jia *et al.*, 2011; Jiang *et al.,* 2011; Dányi, 2013, Kahrarian *et al.*, 2013; Skarżyński *et al.*, 2017), and only about forty in the Nearctic (Christiansen & Bellinger, 1998; Babenko & Fjellberg, 2006; Skarżyński, 2007; Bernard, 2015). Undoubtedly our knowledge of Nearctic *Hypogastrura* is insufficient and the number of recorded species is underestimated. In the *Hypogastrura* material from the Appalachians (USA), which I obtained from Dr Arne Fjellberg, I found a species new to science. Its description is given below.

MATERIAL AND METHODS

Specimens stored in alcohol were cleared in Nesbitt's fluid (chloral hydrate, concentrated hydrochloric acid, distilled water), slide-mounted in a mixed medium of distilled water, arabic gum, glycerol and chloral hydrate, and studied using a Nikon Eclipse E600 phase contrast microscope. Figures were drawn using a camera lucida. Terminology in the description follows that given in Fjellberg (1984, 1999) and Thibaud *et al.* (2004).

TAXONOMIC PART

Hypogastrura arnei sp. nov.

Figs 1-8

Type material: Male holotype, previously in alcohol, now mounted on permanent slide; USA, Tennessee, Sevier County, Great Smoky Mountains National Park, Clingman's Dome (WGS84 35.56212, -83.50425; 1980 m a.s.l.), moss, fir litter, sample number 07.197; 07.06.2007; leg. A. Fjellberg. – Paratypes: 10 females, 10 males, same data as for holotype. Holotype and 13 paratypes deposited in the National Museum of Natural History, Smithsonian Institution, Washington D.C., USA; 5 paratypes in the University of Tennessee Entomology Museum, Knoxville, Tennessee, USA; 2 paratypes in the Muséum d'histoire naturelle de Genève, Switzerland.

Other material: Male on slide; USA, North Carolina, Yancey County, Blue Ridge Parkway, Balsam Gap Overlook (WGS84 35.74837, -82.33337; 1650 m a.s.l.), red spruce litter, sample number 07.167; 04.06.2007;

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leg. A. Fjellberg (deposited in the University of Tennessee Entomology Museum, Knoxville, Tennessee).

Comparative material examined: *Hypogastrura iwamurai* Yosii, 1960: female, previously in alcohol, now mounted on permanent slide, 16 specimens in alcohol; Japan, Hyonosen; 28.08.1938; leg. Yosii. – *Hypogastrura reticulata* Börner, 1909: female, previously in alcohol, now mounted on permanent slide, about 50 specimens in alcohol; Japan, Daimonji, Kyoto; 20.12.1953; leg. R. Yosii. All specimens deposited in the Muséum d'histoire naturelle de Genève, Switzerland.

Etymology: This species is dedicated to Dr Arne Fjellberg, an excellent specialist in Collembola.

Diagnosis: Body oval and slightly flattened. Tegumental granulation coarse. Chaetotaxy plurichaetotic. Antennal segment IV with 4-6 lateral sensilla and 1 dorsal cylindrical sensillum. Postantennal organ equal to or slightly smaller than neighboring ocelli. Labrum with distinct apical papillae. Tibiotarsi with one clavate tenent hair. Empodial lamellae broad. Ventral tube with 4 + 4 setae. Retinaculum with 4 + 4 teeth. Dens with 7 setae and fine, uniform granulation including some slightly larger granules in distal part. Mucro with low lamellae and small subapical tooth. Anal spines minute, papilla absent.

Description: Body length 1.1-1.6 mm. Body oval (Fig. 1) and slightly flattened, abdominal segment VI short and rounded at tip. Color in alcohol uniformly dark blue-grey, eye-patches black. Tegumental granulation coarse and uniform, 3-5 granules between setae p_1 on abdominal tergum V (Fig. 3).

Chaetotaxy of head typical of the genus, with complete set of v-setae. Setae slightly different in lengths (especially on last abdominal segments) and curved. Body sensilla (s) about two times longer than microsetae, fine and smooth. Thoracic tergum I with 3 + 3 setae. Dorsal chaetotaxy of thoracic terga II-III and abdominal terga III-VI as in Figs 2-3: setae m_2, m_3 m_4, m_6 and $m_{6'}$ present. Between thoracic tergum II and end of body (especially on abdominal terga IV and V) additional setae present (plurichaetosis). Subcoxae I, II, III with 1, 4, 4 setae, respectively. Microsensillum on thoracic tergum II present.

Antennal segment IV with simple apical vesicle (av), subapical organite (or), microsensillum (ms), 4-6 lateral sensilla and 1 dorsal cylindrical curved, blunt sensillum (Fig. 6) and 5-7 short pointed setae in ventral field. Antennal segment III organ with two long (outer) and two short (inner) sensilla (Fig. 6). Microsensillum on antennal segment III present. Antennal segment I with 8 setae (seta p' present).

Ocelli: 8 + 8. Postantennal organ equal to or slightly smaller than neighboring ocelli, with four lobes, the anterior pair slightly larger than posterior one. Large accessory boss present (Fig. 7). Labrum with six apical papillae (four large and two small marginal ones). Labral setae 5, 5, 4, prelabrals 4. Maxillary head of *H. tullbergi* type (Fjellberg, 1984: fig. 6). Labial palp as shown in Fjellberg (1999: fig. 6). Outer maxillary lobe with two sublobal hairs.

Tibiotarsi I, II, III with 19, 19, 18 setae, respectively. Apical seta A_1 clavate and slightly longer than inner edge of claw. Claws with inner tooth. Empodial appendage with broad basal lamella and apical filament reaching slightly beyond inner tooth of unguis (Fig. 5).

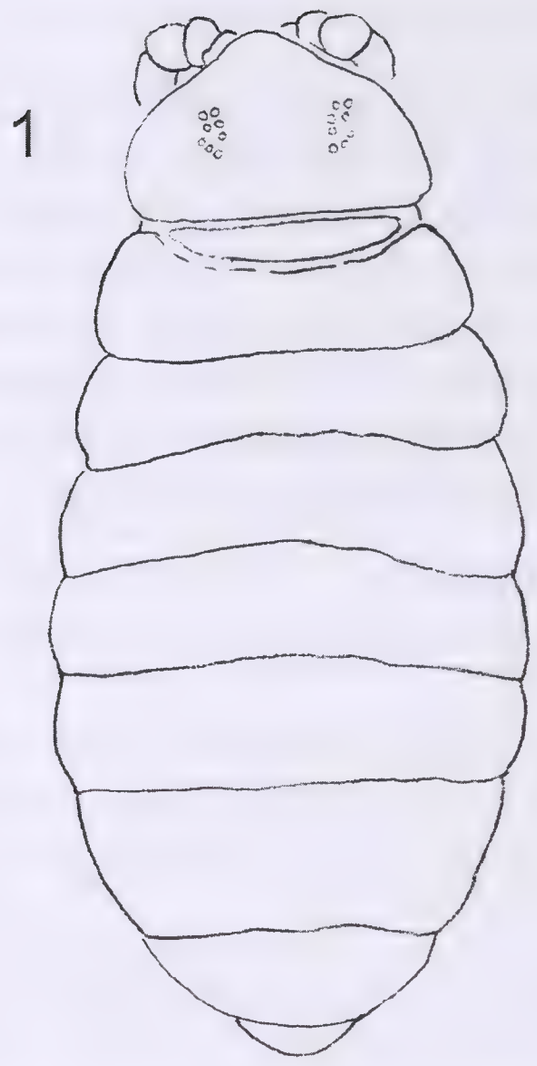
Ventral tube with four setae on each side. Retinaculum with 4 + 4 teeth.

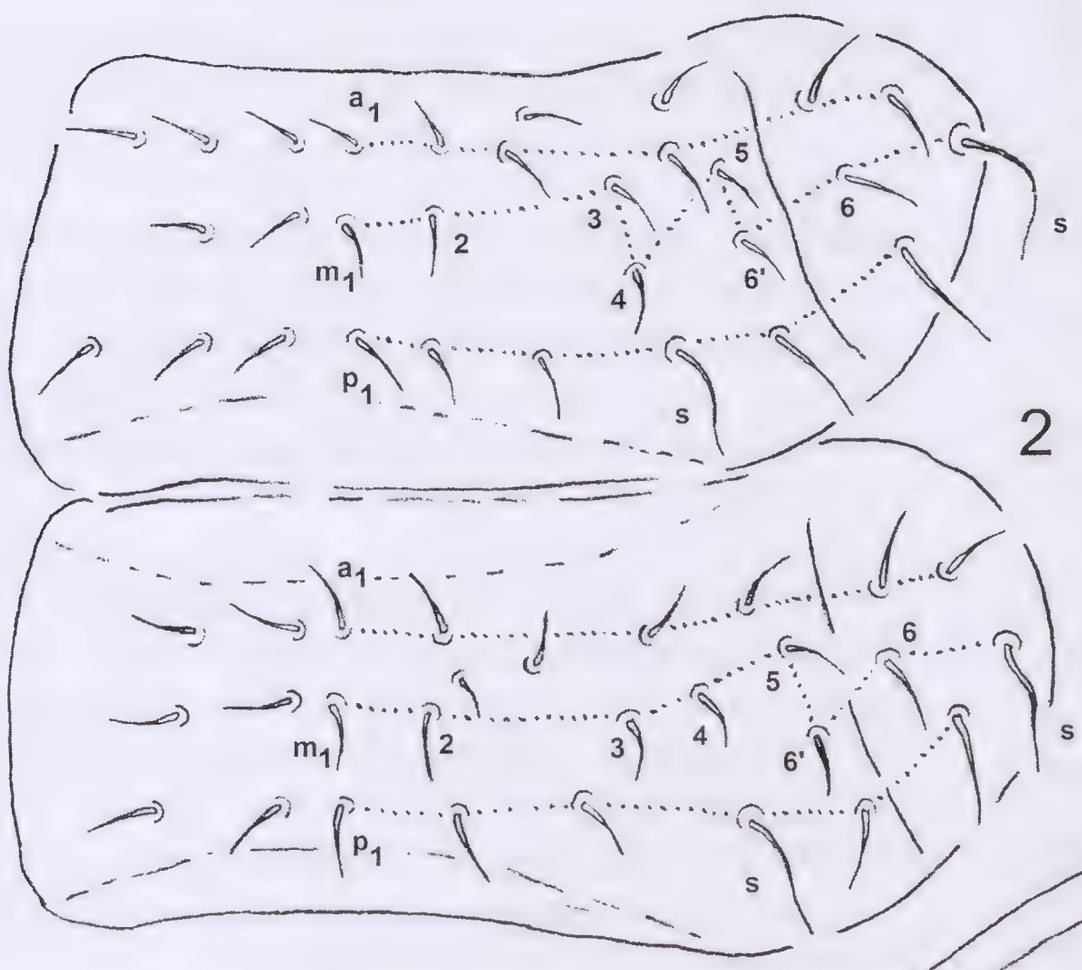
Furca well developed (ratio dens + mucro/inner edge of claw III = 2.7-2.9). Dorsal side of dens with 7 setae and with fine, uniform granulation and some slightly larger but not tooth-like granules in distal part. Apical swelling absent. Mucro with low lateral lamellae (outer one higher than inner one) fusing below apex and forming small subapical tooth. Ratio dens/mucro = 2.2-2.4 (Fig. 8).

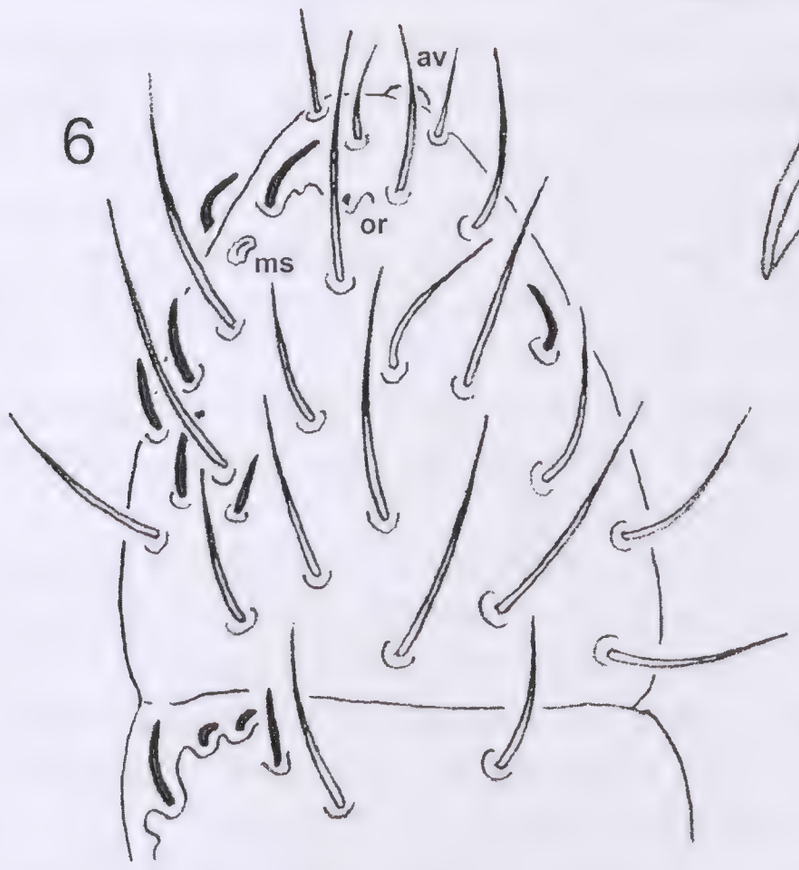
Anal spines narrowly conical, minute (equal to or slightly longer than neighboring granuli, ratio anal spine/inner edge of claw III = 0.1-0.15), papilla absent (Fig. 4).

Remarks: *Hypogastrura arnei* sp. nov. is remarkable for its oval and slightly flattened body, coarse tegumental granulation, plurichaetotic chaetotaxy, antennal segment IV with 4-6 lateral sensilla and 1 dorsal cylindrical, blunt sensillum, moderately modified furca and minute anal spines without papilla. The unusual body shape of the new species deserves special attention. Among known species only *H. iwamurai* Yosii, 1960 seems to be similar in this respect. According to Yosii (1960) the body of that species is „somewhat dorsoventrally flattened as in *Ceratrimeria*". The examination of some specimens of *H. iwamurai* showed that the body of this species is oval and slightly flattened, but its abdominal segment VI is long and tapering posteriorly, while it is short and rounded at the tip in *H. arnei* sp. nov. Moreover, these two species differ considerably in body size (1.1-1.6 mm in *H. arnei* sp. nov. versus "up to 2.5 mm" in *H. iwamurai*), in tegumental granulation (3-5 granules between setae p_1 on abdominal tergum V in *H. arnei* sp. nov. versus 12 in *H. iwamurai*) and in size and shape of the anal spines (narrow-conical, minute, without papilla in *H. arnei* sp. nov. versus short, thick, slightly curved, raised on high papillae in *H. iwamurai*).

Hypogastrura arnei sp. nov. differs also from all the remaining representatives of the genus in the arrangement of cylindrical sensilla on antennal segment IV. Although the new species shares a tendency towards a greater number of lateral sensilla with members of the *nivicola* (= *socialis*), *packardi* (= *sahlbergi*) and *crassaegranulata* groups sensu Christiansen & Bellinger (1980), Babenko *et al.* (1994) and Skarżyński (2009), the presence of a single dorsal sensillum (versus usually 3) places this species at an isolated position. Nevertheless, *H. arnei* sp. nov. is similar to some species of all these groups. Coarse







Figs 1-8. *Hypogastrura arnei* sp. nov. (1) Habitus, dorsal view. (2) Chaetotaxy of thoracic terga II-III. (3) Chaetotaxy of abdominal terga III-VI. (4) Anal spine. (5) Claw III with empodial appendage. (6) Chaetotaxy of antennal segments III-IV, dorsal view. (7) Postantennal organ and adjacent ocelli. (8) Dens and mucro of furca. Scale lines: 1; 2-3; 4; 5-8 to same scale. Abbreviations: av - apical vesicle; or - subapical organite; ms - microsensillum; a_1 - setae of a-row; m_{1-6} - setae of m-row; p_1 - setae of p-row; s - body sensilla.

body granulation and an only moderately modified furca (tooth-like granules, apical swelling on dens and large subapical tooth on mucro absent) make *H. arnei* sp. nov. similar to several Nearctic and Palearctic species/forms. *Hypogastrura macrotuberculata* Hammer, 1953 from Alaska and Canada (Babenko *et al.*, 2019) also has a coarse tegumental granulation, but mainly on the last abdominal terga. Moreover, that species is characterized by the lack of plurichaetosis, by the presence of 1+1 v-setae (rarely 1+2 or 2+2) on the head and by small but not minute anal spines on clear papillae. *Hypogastrura reticulata* sensu Hammer (1953) nec Börner, 1909, an incompletely described species (chaetotaxy unknown) from the Arctic part of Canada, has a special feature that makes it easily distinguishable, i.e. the presence of reticular structures all over the body segments. In addition, it has a hook-like mucro and small but not minute anal spines on clear papillae, and according to Yosii (1960) 1 + 1 v-setae on the head. Among the Palearctic species similar to *H. arnei* sp. nov. are the following members of the *crassaegranulata* group: *H. chouardi* Cassagnau, 1959 (Pyrenees) and *H. hohi* Babenko in Babenko *et al.* (1994) (Caucasus) and *H. reticulata* Börner, 1909 (Japan). The first two, having more than 4 + 4 setae on the ventral tube and a typical dorsal chaetotaxy (plurichaetosis absent), are easy to distinguish. The third, of which I examined some specimens, is unique due to combination of large body size (2.5 mm) and the presence of reticular structures all over the body segments.

Coarse body granulation and a moderately modified furca are also present in summer forms of cyclomorphic species of the *nivicola* (= *socialis*) group: *H. kelmendica* Peja, 1985 (Albania, Croatia, Poland), *H. lapponica* (Axelson, 1902) (Palaearctic) and *H. simsi* Hart & Waltz, 1995 (USA). Their summer and winter forms clearly differ from *H. arnei* sp. nov. in small but not minute anal spines on distinct papillae, and by the abdominal tergum IV without setae m_1 (present in *H. kelmendica*), by a short mucro, ratio dens/mucro about 4 (in *H. lapponica*) and by the dens projecting beyond the apex of the mucro (in *H. simsi*) (Axelson, 1902; Peja, 1985; Babenko *et al.*, 1994; Hart & Waltz, 1995; Christiansen & Bellinger, 1998; Skarżyński & Smolis, 2003).

Finally, plurichaetotic chaetotaxy relates the new species to some members of the *packardi* (= *sahlbergi*) group: *H. austriaca* Babenko & Thibaud, 1990 (Austria, Burgenland), *H. pomorskii* Skarżyński, 2010 (Tien Shan), *H. tatrica* (Stach, 1949) (N Carpathians) and *H. tchabensis* Babenko in Babenko *et al.* (1994) (foreland of the Caucasus) and the *nivicola* (= *socialis*) group: *H. bokusi* Yosii, 1961. Nevertheless, the first four species are distinct, having a fine tegumental granulation and numerous setae (at least 7 + 7) on the ventral tube (Stach, 1949; Babenko & Thibaud, 1990; Babenko *et al.*, 1994; Skarżyński, 2010). *Hypogastrura bokusi* has tooth-like granules on dens and a large subapical tooth on the mucro (Yosii, 1961).

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Three new species in the genus *Latouchia* Pocock, 1901 (Araneae, Mygalomorphae, Halonoproctidae) from Vietnam

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Abstract: The current taxonomy of the trapdoor spider genus *Latouchia* is discussed, and three new species are described from southern Vietnam. *Latouchia stridulans* sp. nov. and *L. schwendingeri* sp. nov. are described from both sexes, *L. huberi* sp. nov. is described from females only. Significant morphological difference between the first species and the second two species indicates that *Latouchia* may need to be split into two or more genera when more information becomes available.

Keywords: Taxonomy - Southeast Asia - Ummidiinae - Rastelloidina - trapdoor spiders.

INTRODUCTION

Godwin *et al.* (2018) recently transferred the genus *Latouchia* Pocock, 1901 from the family Ctenizidae Thorell, 1887 (subfamily Ctenizinae) to the family Halonoproctidae Pocock, 1901 (subfamily Ummidiinae). Three genera (*Ummidia*, *Conothele*, *Latouchia*) are currently included in Ummidiinae, with *Latouchia* as the presumed sister genus of a clade containing the genera *Ummidia* plus *Conothele* (Godwin *et al*., 2018).
Latouchia is taxonomically not well defined and the type specimen(s) appear to be lost (see section "Taxonomy" below). Here the current state of taxonomy of the genus *Latouchia* is discussed and three new species, found in Vietnam, whose type specimens are deposited in the collection of the Natural History Museum of Geneva (MHNG), are described and named.

MATERIAL AND METHODS

Measuring methods: Morphometric measurements of body parts, eyes, legs and palps were taken as indicated in Figs 1-6. Total lengths of legs and palps are given as the sum of length measurements of individual segments (e.g. length of tarsus + metatarsus + tibia + patella + femur). Measurements taken at lower magnifications (legs, larger body parts) are given to an accuracy of 0.1 mm, measurements taken at higher magnifications (eyes, copulatory organs) are accurate to 0.01 mm.

Sample description: The available spider material consists of eleven *Latouchia* specimens in three museum samples, collected at three different localities (Mui Nai Beach, Hang Tien and Dambri Waterfall) in southern Vietnam. Because each sample contained more than one specimen (MHNG sample numbers, see Table 1), each individual specimen was given a unique identification number (ID-numbers, see Table 1). This allowed a study of species unity and individual variation. The descriptions of colouration refers to observations made on specimens fully submerged in 70% ethanol.

Illustrations of copulatory organs: Because of its asymmetrical structure, the male bulb (= palpal organ) is shown in four different views, as rotated around its longitudinal axis (see Figs 19-26). The drawings are made from the detached right bulb of the specimen described. The female spermathecae are shown in ventral view, after having removed the covering cuticle and the fatty tissue and gland tissue around the receptacles with fine sharp tools (see Figs 18, 38-39, 46-47). The receptacles were left in situ.

Equipment: All specimens were examined with the aid of a Huvitz HSZ-645TR stereomicroscope equipped with a Lusis HC-20CU camera. Morphological details were studied using a Euromex iScoop compact microscope equipped with a CMX-500 camera. Both systems allow multiple focus stacking and precision measurement.

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Table 1. Summary of available samples with individual codes, museum codes, localities, sex and size indications for individual specimens.

Individual specimen ID	MHNG sample number	Localities	Sex and size
PS-018	SV-03/04	Mui Nai Beach	Female, CL = 5.0 mm
PS-019	SV-03/04	Mui Nai Beach	Female, CL = 5.3 mm
PS-020	SV-03/04	Mui Nai Beach	Female, CL = 6.2 mm
PS-021	SV-03/04	Mui Nai Beach	Juvenile, CL = 6.2 mm
PS-023	SV-03/04	Mui Nai Beach	Female, CL = 5.6 mm
PS-024	SV-03/04	Mui Nai Beach	Juvenile, CL = 4.1 mm
PS-022	SV-03/05	Hang Tien	Male, CL = 3.9 mm
PS-016	SV-03/05	Hang Tien	Female, CL = 4.2 mm
PS-017	SV-03/05	Hang Tien	Female, CL = 4.3 mm
PS-014	SV-03/18	Dambri Waterfall	Male, CL = 6.9 mm
PS-015	SV-03/18	Dambri Waterfall	Female, CL = 7.5 mm

Drawings were made directly from the specimens using a Ceti Medo II stereomicroscope with a drawing tube.

Abbreviations: See also Figs 1-6; AR = anterior eye row width; BuL = length of bulb (in dorsal view); BuW = width of bulb (in dorsal view); CL = carapace length; CP = length of cephalic part of carapace; CW = carapace width; dALE = diameter of anterior lateral eye; dAME = diameter of anterior median eye; diAME = distance between anterior median eyes; diPME = distance between posterior median eyes; dPLE = diameter of posterior lateral eye; dPME = diameter of posterior median eye; EL = eye group length; EmL = length of embolus; Ext = external distance between receptacles; Int = internal distance between receptacles; LL = labium length; LL1 = length of first leg; LL2 = length of second leg; LL3 = length of third leg; LL4 = length of fourth leg; LW = labium width; MaxL = maxilla length; PaL = palp length; PFe = length of palp femur; PLS = posterior lateral spinnerets; PMS = posterior median spinnerets; PR = posterior eye row width; PTi = length of palp tibia; SL = sternum length; SW = sternum width; TBL = total body length.

Museum acronyms: MHNG = Natural History Museum, Geneva; MNHN = Natural History Museum, Paris.

TAXONOMIC PART

Latouchia Pocock, 1901

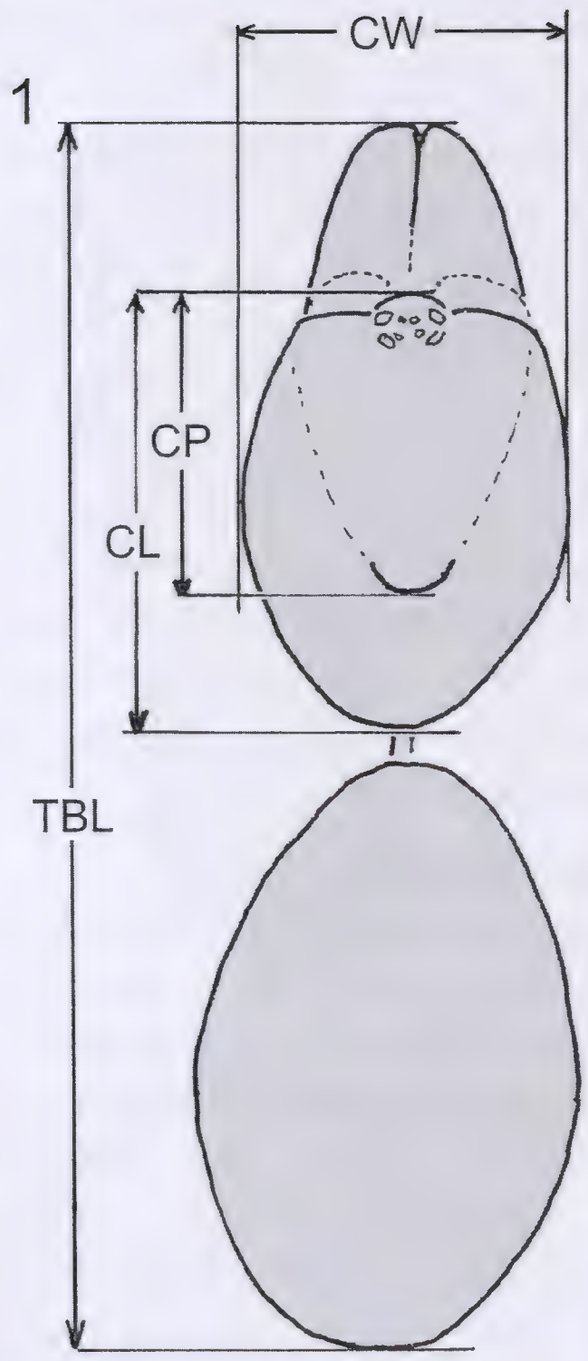
Latouchia Pocock, 1901: 210; established to accommodate three species previously misplaced by Simon (1886: 162-163 and 1897: 253) in *Acattyma* (= *Antrodiaetus*) plus two additional species from China and Japan.

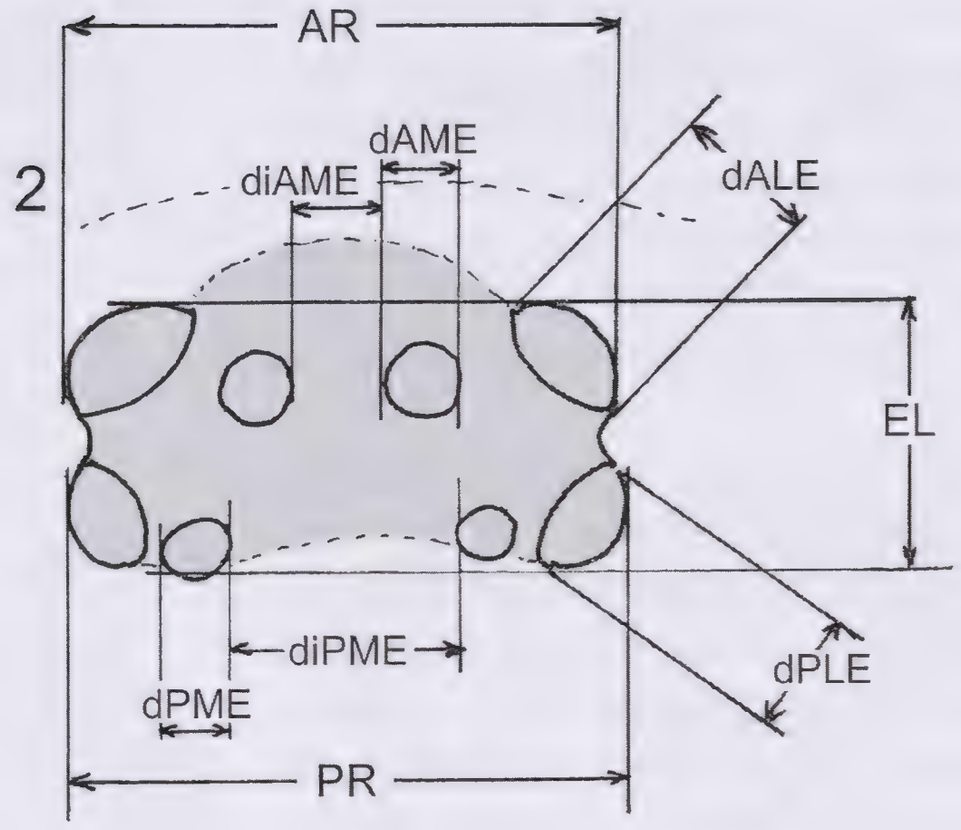
Cronenbergella Charitonov, 1946: 19, see Raven (1985: 151).

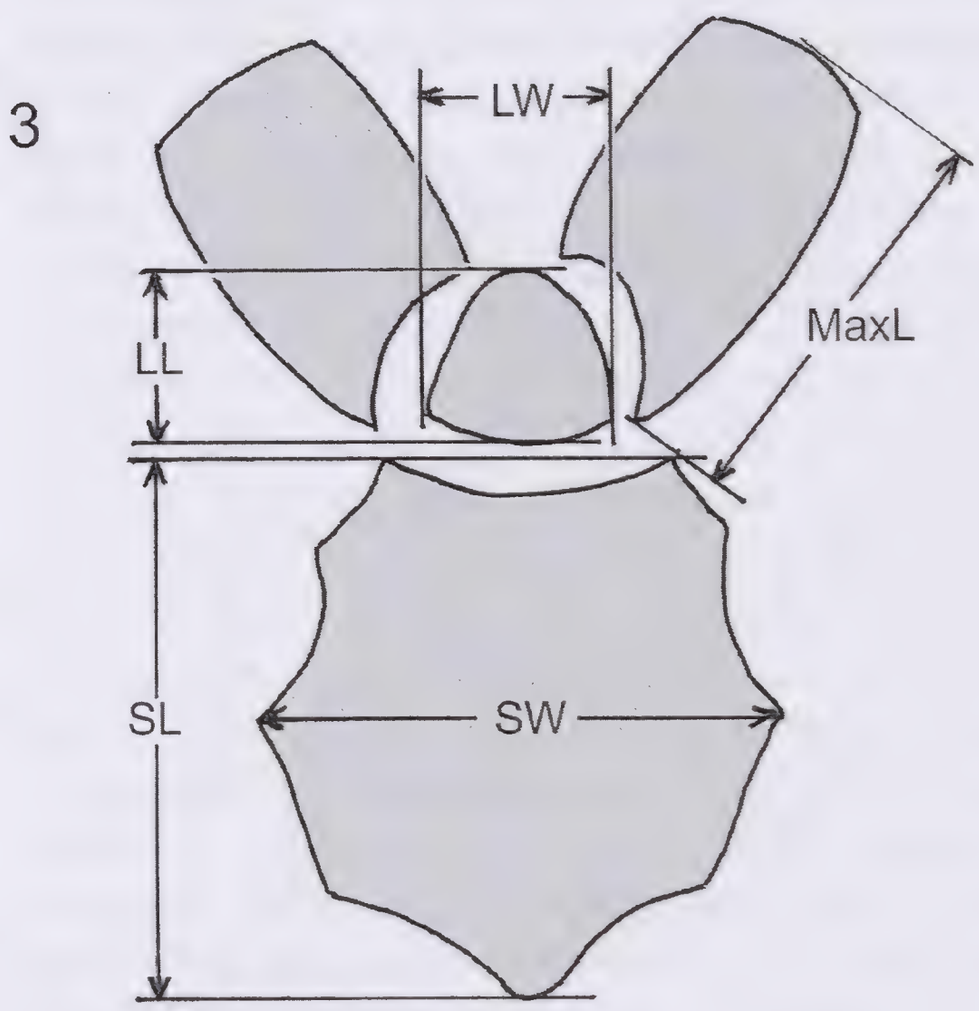
Diagnosis: The genus *Latouchia* differs from other Ummidiinae by the absence of a proximal 'saddle-shaped depression' in the dorsal side of tibia III and by the absence of a protuberant, prodorsal apophysis (spur) on trochanter III (see Decae, 2010: fig. 1). As presently understood, *Latouchia* is the only rastelloid trapdoor spider genus without a saddle-shaped depression in tibia III but with clavate tarsal trichobothria.

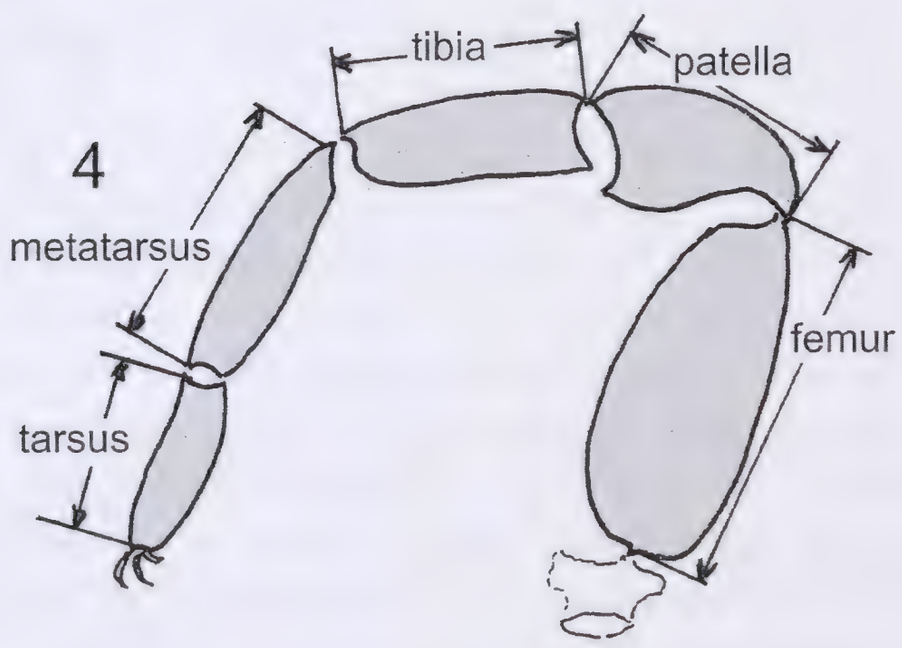
Taxonomic and geographic remarks: Pocock (1901: 210-211) regarded *Latouchia* as closely related to *Cytrocatenum* (family Ctenizidae, sub-family Ctenizinae). He correctly described *Latouchia* as a trapdoor spider genus with typical rastelloid characters such as being strongly built, having a high elevated cephalic part of the carapace in females, a deep and strongly procurved fovea in both sexes, large orthognathous chelicerae, two pairs of short spinnerets, and the proximal segments of the PLS wider than long. Some characters in Pocock's description (a high ocular tubercle and sigilla fused to form a shallow Λ-shaped groove in the middle of the sternum), however, are not found in the Ctenizinae as they are understood today. These characters, combined with those mentioned by Pocock, place *Latouchia* within the Ummidiinae (family Halonoproctidae). The absence of lateral sigilla and the presence of clavate tarsal trichobothria (not mentioned by Pocock), further support the placement of *Latouchia* within the Ummidiinae on morphological grounds. Godwin *et al.* (2018: 308) confirmed this placement using morphological and molecular arguments. *Latouchia*, as understood here, is the only umminiine genus lacking the conspicuous saddle-shaped depression in tibia III (see diagnosis).

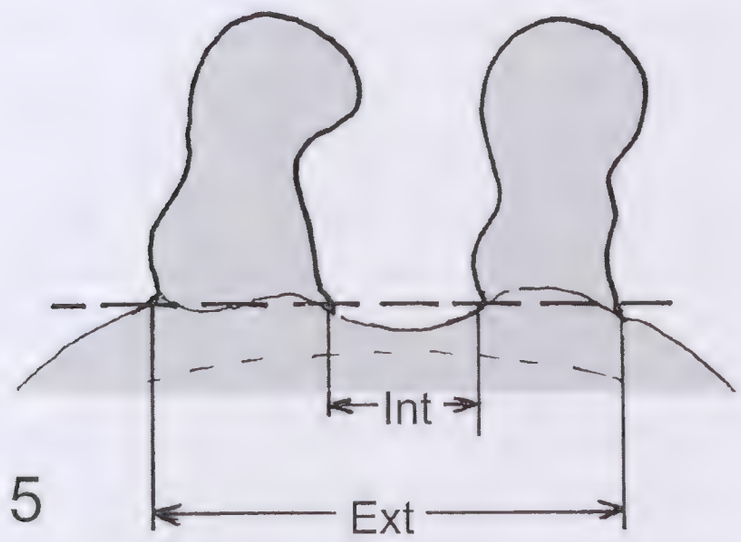
Although seventeen *Latouchia* species (and one subspecies) are regarded as valid in the World Spider Catalog (2019), the genus is relatively poorly known.

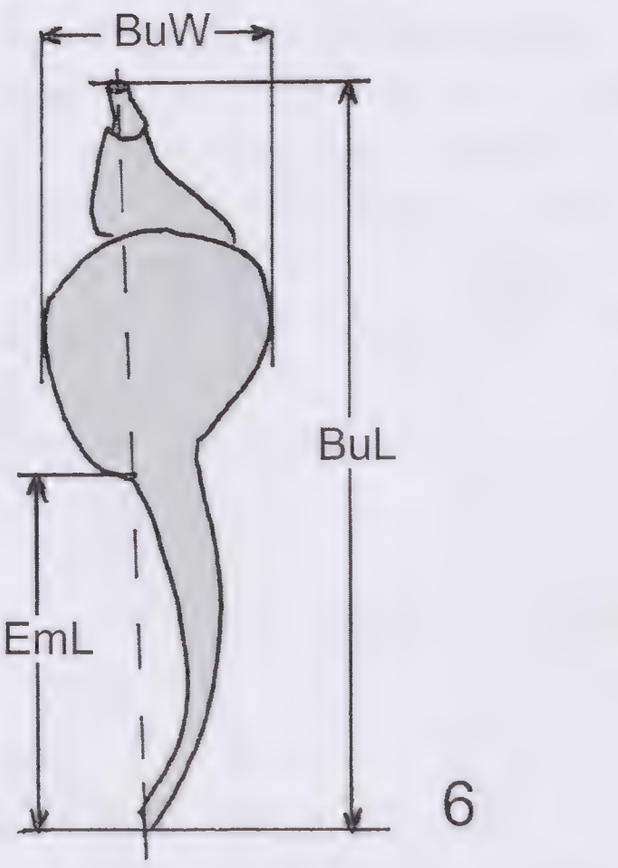












Figs 1-6. Explanation of measurements of in *Latouchia*. (1) Dorsal habitus: CL = carapace length; CP = length of cephalic part of carapace; CW = carapace width; TBL = total body length. (2) Eye group: AR = anterior eye row width; dALE = diameter of anterior lateral eye; dAME = diameter of anterior median eye; diAME = distance between anterior median eyes; diPME = distance between posterior median eyes; dPLE = diameter of posterior lateral eye; dPME = diameter of posterior median eye; EL = eye group length; PR = posterior eye row width. (3) Ventral side of cephalothorax: LL = labium length; LW = labium width; MaxL = maxilla length; SL = sternum length; SW = sternum width. (4) Measurements of segments of palps and legs. (5) Spermathecae: Ext = external distance between receptacles; Int = internal distance between receptacles. (6) Bulb: BuL = length of bulb (in dorsal view); BuW = width of bulb (in dorsal view); EmL = length of embolus.

Several species are briefly or incompletely described. Only eight *Latouchia* species have both sexes described. Eight other species are known exclusively from females, and one species from the male only. Nine species have no more than one reference in the literature, six of these single references are more than fifty years old. The existence of all these single-reference-species remains to be confirmed.

Another complication in the taxonomy of *Latouchia* is that the three earliest recorded species, all described by Simon (1886, 1897), had originally been misplaced in the genus *Acattyma* (L. Koch, 1878). Pocock (1901) recognized that Simon's *A. davidi*, *A. cunicularia* and *A. cryptica* had been misplaced and he therefore established the genus *Latouchia* to contain Simon's *Acattyma* species as well as two newly discovered species. Simon (1903: 890) acknowledged Pocock's new genus and the transfer of his *Acattyma* species to *Latouchia*. Pocock (1901) described two additional species, *L. fossoria* from China and *L. swinhoei* from Japan, and he designated *L. fossoria* as the type species of the genus *Latouchia* (Pocock, 1901: 211). This designation, however, is not recognized in the current version of the World Spider Catalog (2019), where *L. davidi* (Simon, 1886) (one of the two earliest described species) is given as the type species of *Latouchia*. This ambiguous information leads to further taxonomical complications, firstly because the holotype of *L. davidi* might be lost, and secondly because the type locality given by Simon (1886: 163) is difficult to trace. According to geographical information given in the World Spider Catalog (2019), *L. davidi* occurs in China. However, the type locality given by Simon (1886: 163), "Mou-Pin", might refer to "Khong Mou Pin" (22.483°N, 103.317°E) in northern Vietnam. Given the above, information about *Latouchia* provided in the World Spider Catalog (2019) needs correction. *Latouchia fossoria* should be indicated as type species of the genus, and the geographical origin of *L. davidi* should be indicated as eastern Asia. The question if Simon's *Acattyma davidi*, *A. cunicularia* and *A. cryptica* were correctly transferred to *Latouchia* remains open until the type specimen of these species have been recovered.

***Latouchia stridulans* sp. nov.**

Figs 7-22, 48-49

Types: MHNG, sample SV-03/18; male holotype (ID: PS-014; matured on 1.XI.2004), one female paratype (ID: PS-015); Vietnam, Lam Dong Province, Dambri Waterfall, ca 18 km north of Bao Loc; WGS84 11.6450, 107.7435; alt. 850 m, old secondary forest, roadside; 2.09.2003; leg. P. J. Schwendinger.

Etymology: The species name, a Latinised present participle, refers to the presence of a conspicuous and supposedly diagnostic series of crescent-shaped ridges on the retrolateral side of the basal segment of the chelicerae, here interpreted as part of a stridulatory organ.

Diagnosis: This species is distinguished from all known *Latouchia* species, for which sufficient information is available, by the presence of a series of crescent-shaped ridges (presumably part of astridulatory organ) on the retrolateral side of the basal segment of the chelicerae (Fig. 11). This character is present in both sexes. The new species furthermore differs from other *Latouchia* species in the morphology of the spermathecae, which are only slightly constricted in the distal half of both parallel receptacles (Fig. 18), and in the long, slender and regularly curved embolus with a small, subapical triangular side tooth (Figs 19-22).

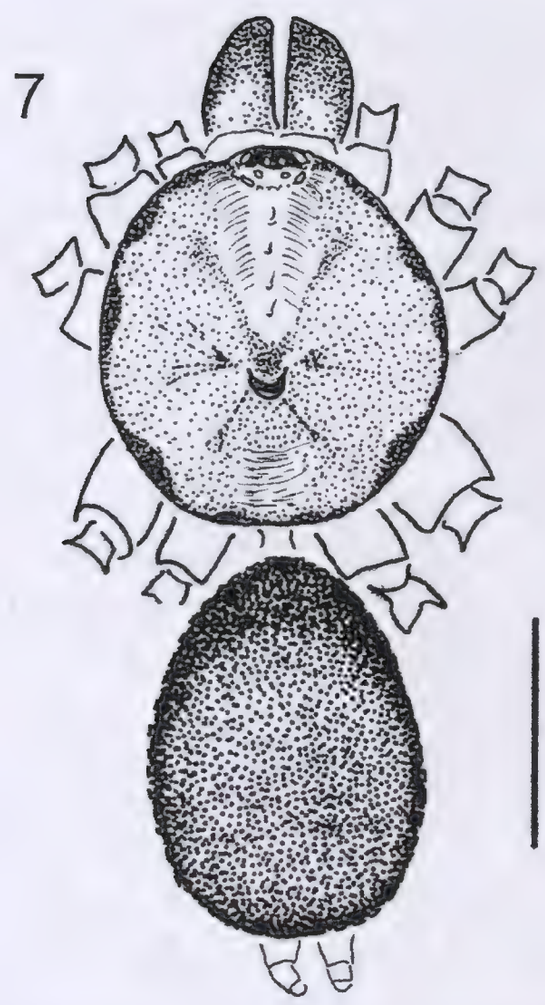
Description of male (holotype)

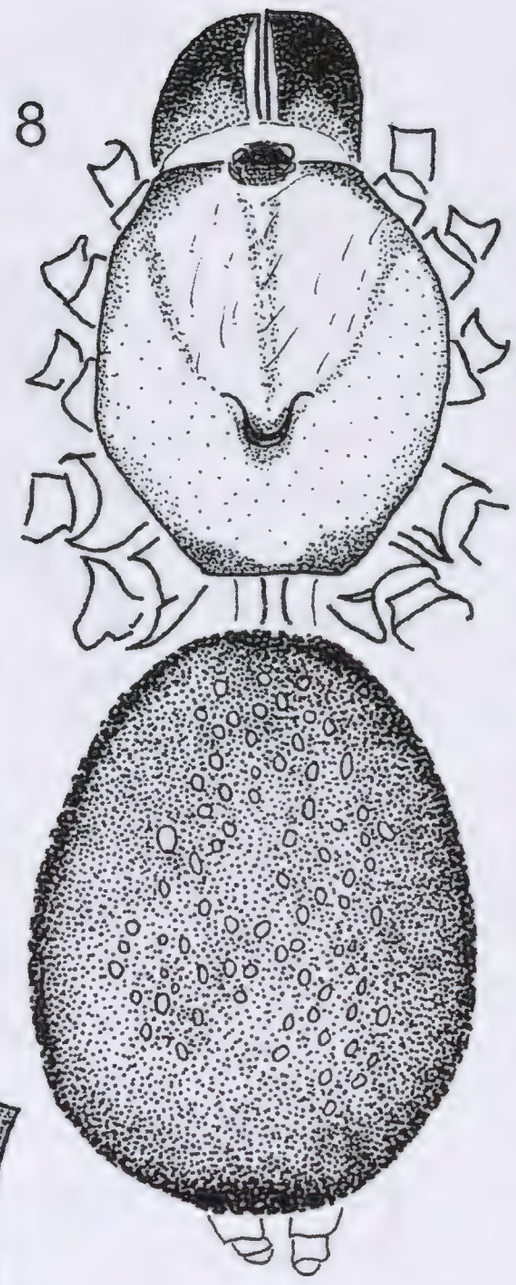
Colouration: Carapace uniformly dull dark brown with some shading, darkest along the edges. Chelicerae distinctly bicoloured, ventrally and proximally yellow, distally brown. Abdomen dorsally uniformly blackish grey, ventrally creamy yellow with numerous dark blotches between posterior booklungs and spinnerets. Sternum, labium, maxillae and ventral side of leg coxae yellow. Spinnerets creamy white. Distal segments of legs and palps yellow, proximal segments brown, femora entirely dark brown in palps and legs I-II, only dorsally brown in legs III-IV.

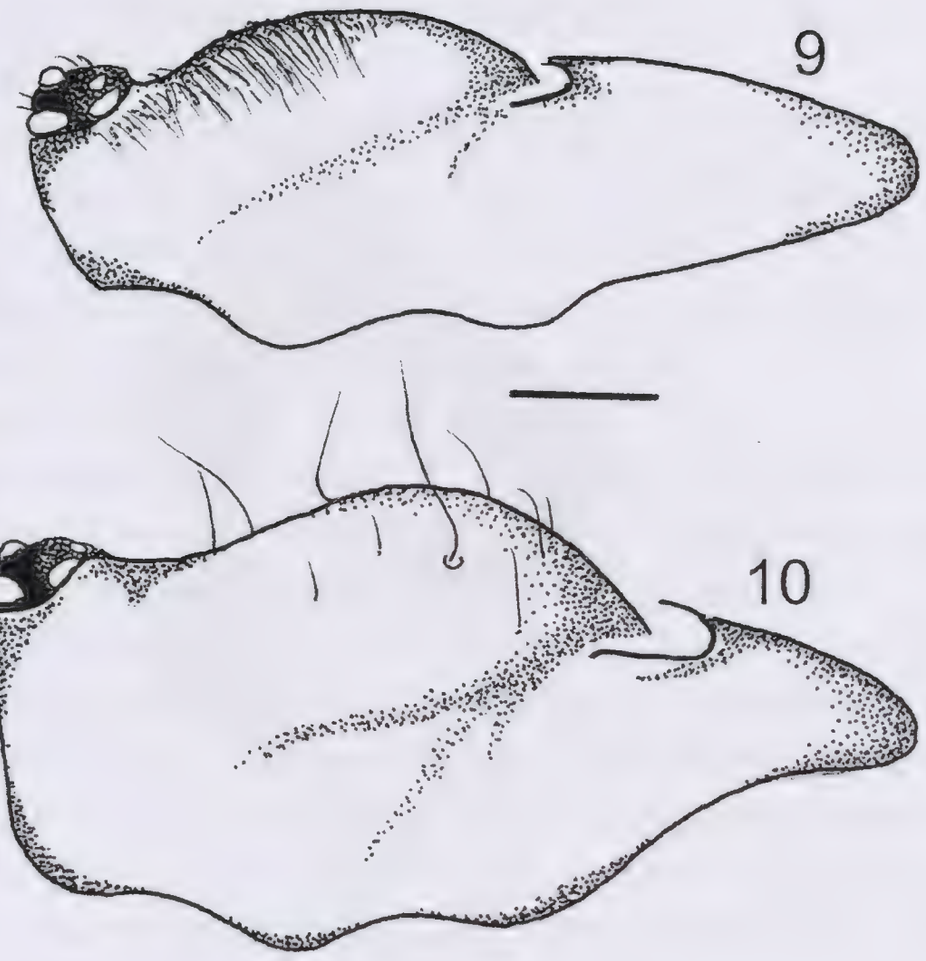
Carapace (Figs 7, 9): Slightly longer than wide (w/l = 0.9), with thickened rim around lateral and posterior edges, cuticle coriaceous (terminology following Pocock, 1901), with fine grainy texture and wrinkles between eyes and fovea, glabrous except for few fine bristles on cephalic part. Cephalic part slightly elevated (Fig. 9), rising gradually from eye group before sloping in a regular curve down to fovea. Fovea procurved, crescent-shaped. Thoracic part gradually descending from fovea to posterior edge of carapace (Fig. 9). Clypeus very narrow, hidden under forward-projecting ocular mound. Eye group on elevated mound (Fig. 9), almost twice as wide as long (EL/PR = 0.55), slightly trapezoidal, PR slightly wider than AR (AR/PR = 1.03); lateral eyes larger than median eyes. AME less than their diameter apart, anterior eyes grey, posterior eyes pearly white.

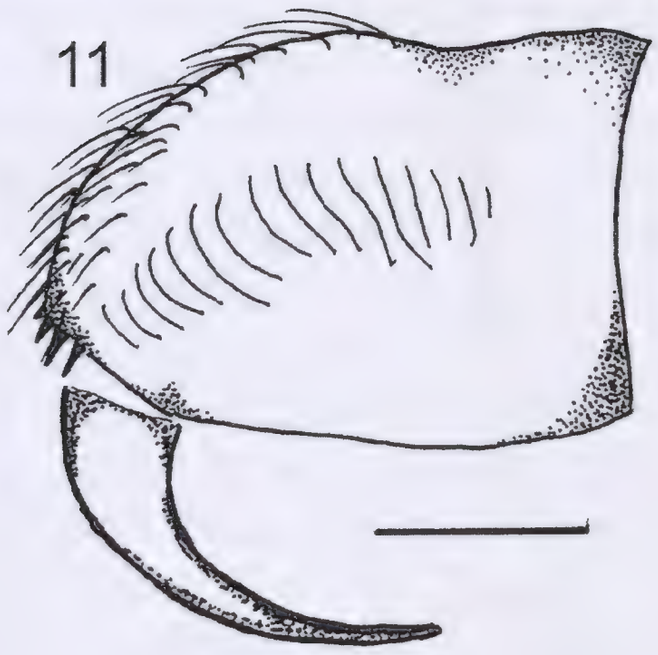
Chelicerae: Retrolateral series of distinct regularly-spaced, crescent-shaped ridges and depressions over the length of the basal segment forming the rasp of a stridulatory organ (Fig. 11). Dorsally glabrous zone separating longitudinal bands with fine bristles, these distally merging into a field of stronger bristles and apical rastellar teeth. Rastellum on small elevation. Ventral fang groove lined on both sides with rows of small conical teeth (five in prolateral row, four in retrolateral row). Fang long and sharply pointed (Fig. 11).

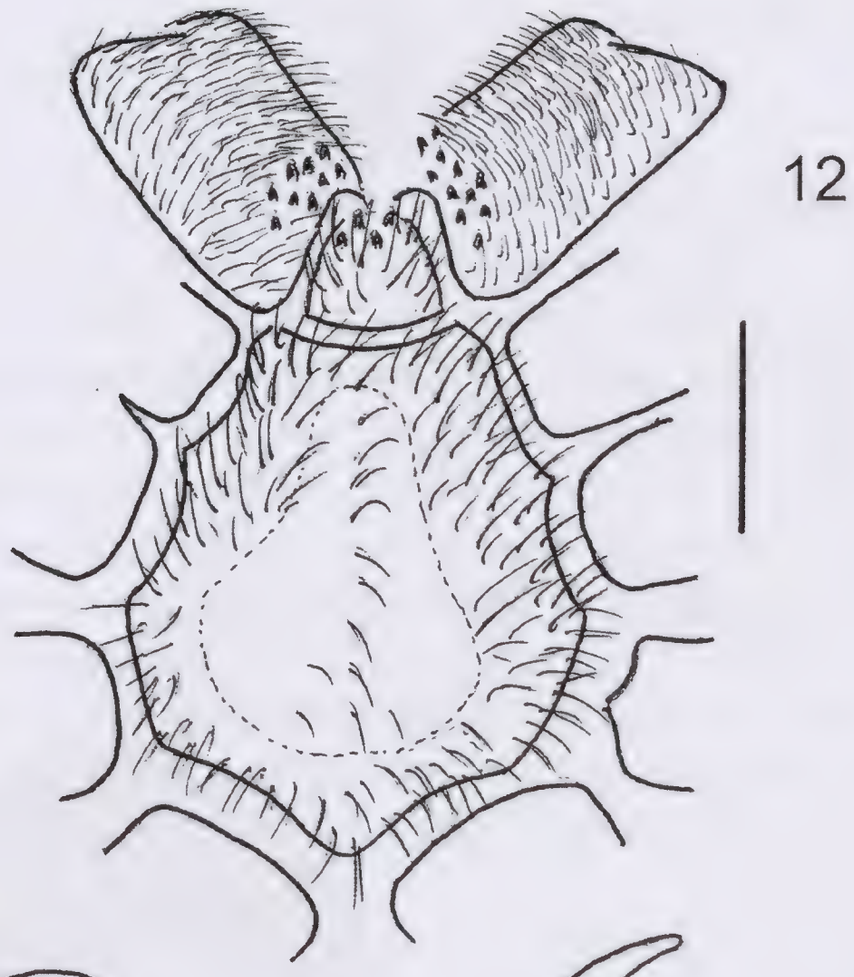
Ventral side of cephalothorax: Sternum slightly longer than wide (w/l = 0.9), narrowing anteriorly, widest between coxae II and III. Central sigilla large, fused, extending forward, with a single, longitudinal, median

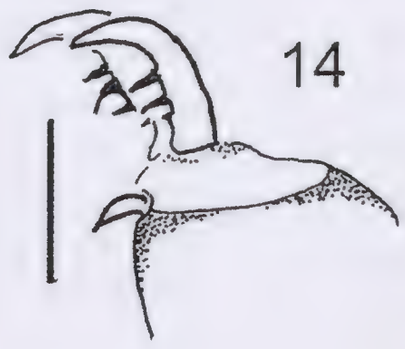


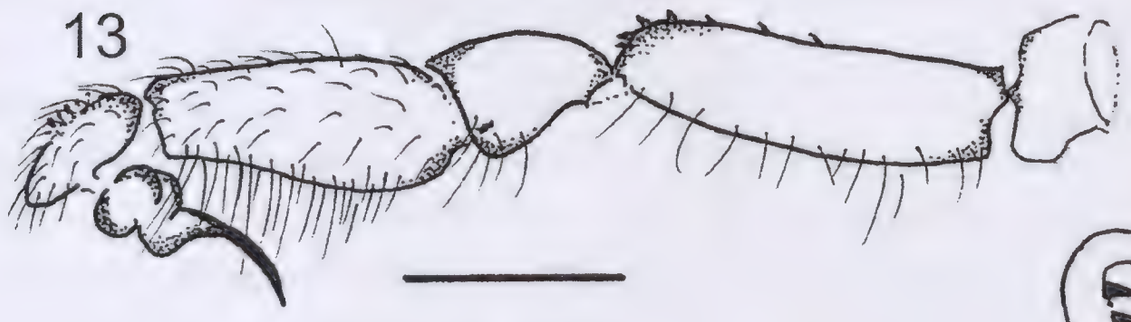


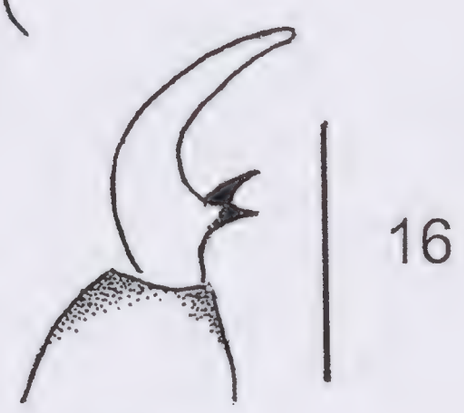


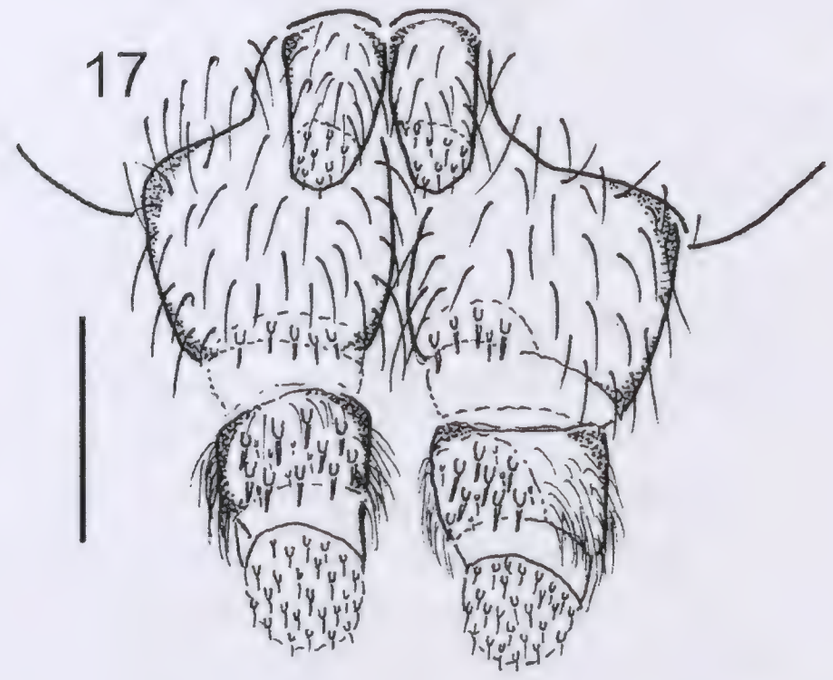




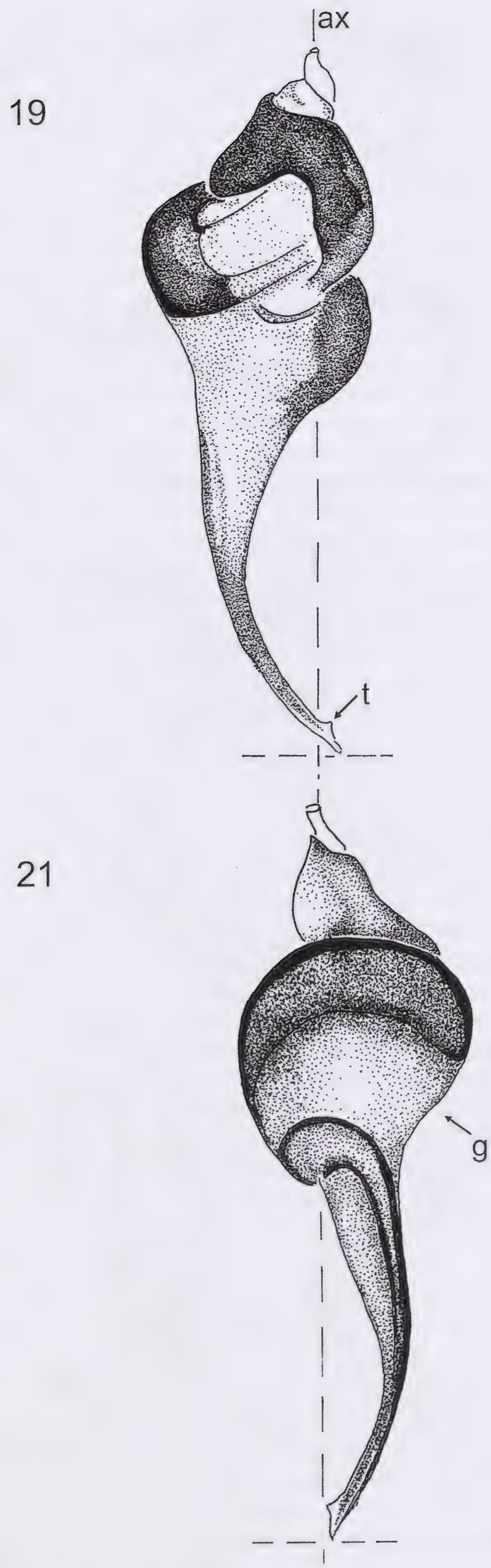








Figs 7-18. *Latouchia stridulans* sp. nov. (7) Dorsal habitus of male holotype (ID: PS-014). (8) Dorsal habitus of male paratype (ID: PS-015). (9) Lateral view of carapace of male. (10) Idem, of female. (11) Left chelicera in retrolateral view (note stridulatory ridges). (12) Ventral side of cephalothorax of female (note fused central sigilla with central longitudinal row of bristles). (13) Left palp of male in retrolateral view. (14) Tarsal claws of leg I of male. (15) Tarsal claws of leg I of female. (16) Palp claw of female (note bifid tooth). (17) Spinnerets of female in ventral view. (18) Spermathecae in ventral view. Scale lines with number of millimetres between parentheses: Figs 7-10 (5); Figs 12-13 17 (2); Fig. 11 (1); Figs 14-16, 18 (0.5).



Figs 19-22. *Latouchia stridulans* sp. nov., male holotype (ID: PS-014), bulb with rotation axis (ax) indicated by broken line. (19) Ventral view (t = triangular tooth). (20) Retolateral view. (21) Dorsal view (g = globular part of bulb). (22) Prolateral view. Scale line 0.5 mm.

row of fine bristles. Labium semicone-shaped, truncated at anterior margin, wider than long (w/l = 1.2). A single apical cuspule present. Maxillae longer than wide, roughly rectangular, distal prolateral heel absent, group of small cuspules present along proximal edge.
Palps (Fig. 13): Cymbium spineless, with dorsal groups of 11 to 13 clavate trichobothria. Tibia proximally slightly inflated, with dense ventral group of strong bristles over full length of segment. Femur with small but distinct group of curved, short, thorn-like spines dorso-distally. Tibia and femur not longer than half length of carapace (PTi/CL = 0.4; PFe/CL = 0.5). Bulb (Figs 19-22) with proximal part globular in dorsal view (Fig. 21), clearly separated into a proximal and a distal part in pro- and retrolateral view (Figs 20, 22). Embolus long, nearly half length of total bulb (EmL/BuL = 0.48), regularly curved (best seen in ventral and dorsal view (Figs 19, 21), subapically with a distinct triangular "tooth" visible only in ventral and dorsal view (Figs 19, 21).
Legs: All tarsi scopulate, furnished with small, very fine spines and, except for tarsus IV, with few dorsal clavate trichobothria. Lateral groups of short, sharp spines on anterior metatarsi and tibiae; stronger short spines present on patellae and in particular in dorsal distal zone of femora. Leg III with numerous spines on all segments, most prominent in dorsal prolateral zone of trochanter, distal patellar spines arranged in a short transverse row. Leg IV with short spines on all segments except coxa.
Paired claws (Fig. 14): Three or four sharp teeth of different lengths, distal or subdistal tooth longest. Unpaired claw smooth.
Abdomen (Fig. 7): Ovoid, soft, with evenly spaced short bristles.
Spinnerets: As in female (see below).
Measurements: TBL 16.6; CL 6.9; CW 6.3; CP 4.2; AR 1.10; PR 1.13; EL 0.62; dALE 0.32; dPLE 0.32; dAME 0.20; dPME 0.18; diAME 0.13; diPME 0.37; SL 3.7; SW 3.4; LL 0.8; LW 1.1; MaxL 2.1; PaL 9.1 (1.3 + 2.5 + 1.8 + 3.5); LL1 19.5 (1.5 + 3.8 + 5.0 + 3.0 + 6.2); LL2 17.3 (1.6 + 3.5 + 3.7 + 2.9 + 5.6); LL3 16.5 (1.9 + 4.1 + 3.1 + 2.6 + 4.8); LL4 22.2 (2.3 + 5.2 + 5.2 + 3.0 + 6.5); BuL 2.26; BuW 0.75; EmL 1.08.

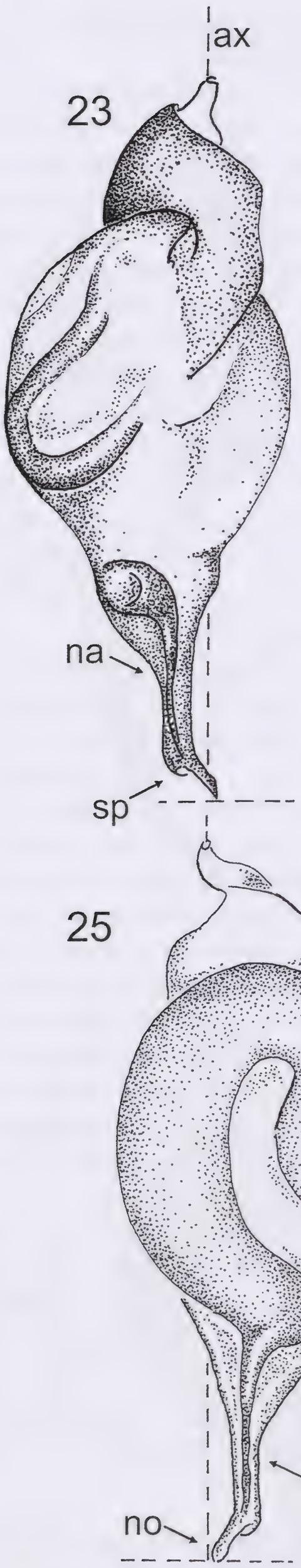
Description of female (paratype)
Colouration: Generally as in male, but slightly lighter and more shaded brown carapace and lighter grey dorsal side of abdomen.
Carapace (Figs 8, 10): Longer than wide (CW/CL = 0.9), cephalic part strongly elevated, with shallow saddle-shaped depression between ocular mound and highest elevation shortly anterior of a steep decent to fovea (Fig. 10). Texture of cuticle smooth, few bristles of very different lengths and strengths widely scattered over cephalic part. Few very fine bristles on thoracic part. Fovea with outward curving ends (Fig. 8). Slope of thoracic part, clypeus and eye group as in male.
Chelicerae: Stronger than in male. Rastellum on a low elevation. Rows of teeth on either side of the fang groove stronger than in male.
Ventral side of cephalothorax (Fig. 12): Sternum as in male. Labium shaped as in male, but with small distal group of four cuspulus. Maxillae shaped as in male, prolateral distal heel strongly reduced, with a group of about 20 cuspules along proximal margin.
Palps: Tarsus with dorsal group of 11 to 13 clavate trichobothria, tarsus and tibia with dense lateral groups of mainly curvy spines over full lengths of segments, tarsal claw with one bifid proximal tooth (Fig. 16).
Legs: Posterior two pairs stronger than anterior two pairs, with clavate trichobothria as in male, distal three segments of legs I-II with dense groups of mainly curvy spines on their lateral surfaces, ventrally spineless, curvy spines absent from posterior legs. Spines on patella and metatarsus III situated dorsally, no trochanter spines as in male but long bristles instead.
Paired claws (Fig. 15): With proximal two to four teeth of different lengths, distal ones longest.
Abdomen: Larger than in male.
Spinnerets (Fig. 17): PMS one-segmented, digitiform, with light-coloured apical spigot field. PLS three-segmented, with macrospigots present on all segments. Proximal segment as wide as long, slightly cone-shaped, with narrow ventroapical spigot field, median segment short and cylindrical, its ventral spigot field with 7-9 prominent macrospigots irregularly distributed, distal segment very short and dome-shaped, apical spigot field with one or two central macrospigots.
Spermathecae: Monopartite parallel receptacles column-shaped, with only a slight constriction subcentrally and fully covered with gland pores for their entire length (Fig. 18).
Measurements: TBL 20.4; CL 7.5; CW 6.4; CP 5.1; AR 1.23; PR 1.28; EL 0.68; dALE 0.31; dPLE 0.33; dAME 0.20; dPME 0.22; diAME 0.13; diPME 0.41; SL 4.5; SW 4.0; LL 1.1; LW 1.3; MaxL 2.6; PaL 12.4 (2.7 + 2.8 + 2.6 + 4.3); LL1 13.7 (1.2 + 1.9 + 2.9 + 3.1 + 4.6); LL2 12.4 (1.2 + 1.9 + 2.3 + 2.8 + 4.2); LL3 12.4 (1.6 + 2.2 + 1.9 + 2.6 + 4.1); LL4 17.1 (1.8 + 3.1 + 3.5 + 3.3 + 5.4); Int 0.31; Ext 0.84.

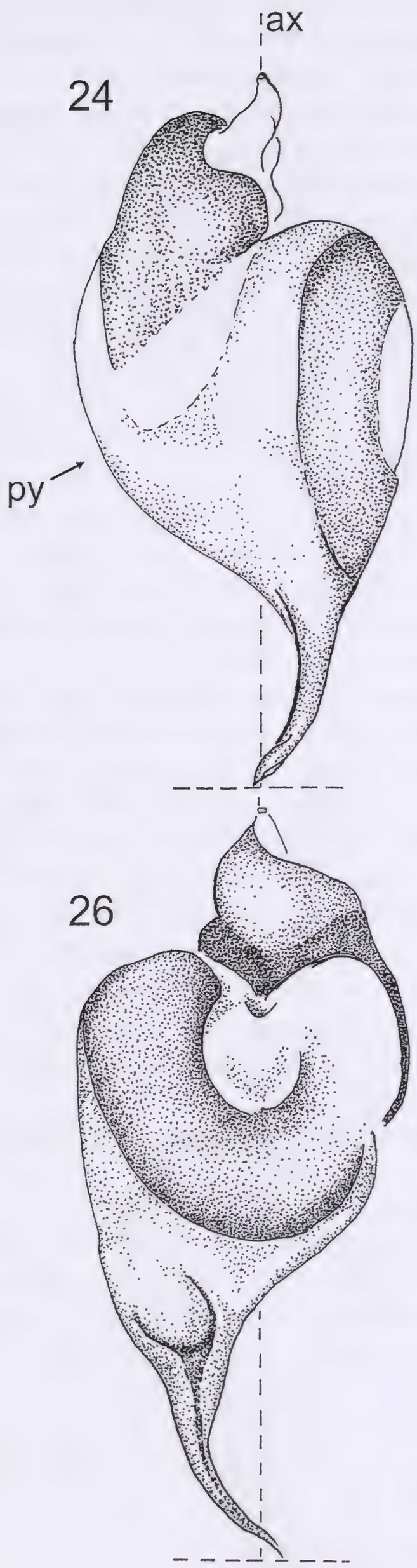
Biology: The type specimens were collected from earth banks on one side of a dirt road in an old secondary forest near a waterfall. The burrows were quite short (not much longer than the spiders themselves) and had two wafer-like trapdoors. The backdoor opened into a blind chamber behind the burrow into which the spiders retreated when the front door was forced open.

Latouchia schwendingeri sp. nov.

Figs 23-39, 50-51

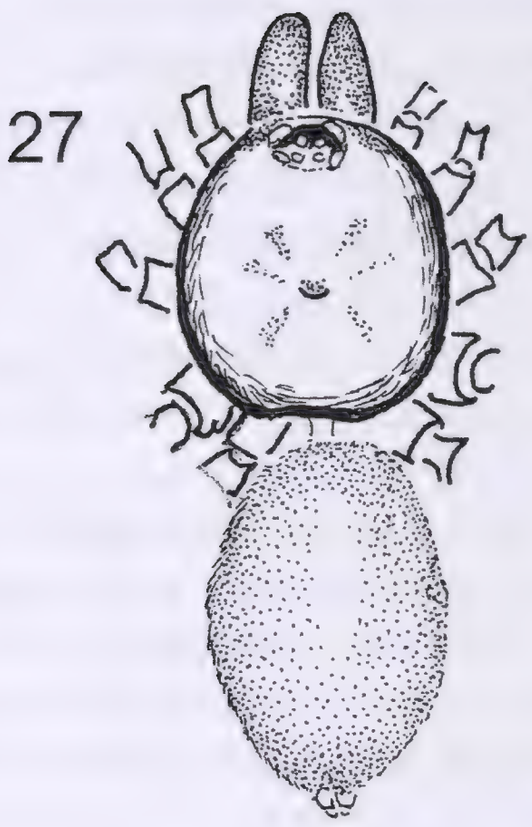
Types: MHNG, sample SV-03/05; male holotype (ID: PS-022; matured in early June 2004), one female allotype (ID: PS-016) and one female paratype (ID:





Figs 23-26. *Latouchia schwendingeri* sp. nov., male holotype (ID: PS-022), bulb with rotating axis (ax) indicated by broken vertical line. (23) Ventral view (na = medial abrupt narrowing of embolus; sp = spermductpore). (24) Retolateral view (py = pyriform proximal part). (25) Dorsal view (no = nose; sd = spermduct). (26) Prolateral view. Scale line 0.5 mm.

Figs 27-39. *Latouchia schwendingeri* sp. nov. (27) Dorsal habitus of male holotype (ID: PS-022). (28) Dorsal habitus of female allotype (ID: PS-016). (29) Lateral side of carapace of male. (30) Idem, of female. (31) Left chelicera of female in retrolateral view (note absence of stridulatory ridges). (32) Ventral Cephalothorax of female (note indistinctly fused central sigilla). (33) Left palp of male in retrolateral view (note elongated tibia, patella and femur). (34) Tarsal claws of leg I of male. (35) Tarsal claws of leg I of female. (36) Palp claw of female (note single sharp tooth). (37) Spinnerets of female in ventral view. (38) Spermathecae of female allotype (ID: PS-016) in ventral view. (39) Spermathecae of female paratype (ID: PS-017) in ventral view. Scale lines with numbers of millimetres between parentheses: Figs 27-30 (5); Figs 32-33 (2); Fig. 31 (1); Figs 37-39 (0.5); Figs 34-36 (0.2).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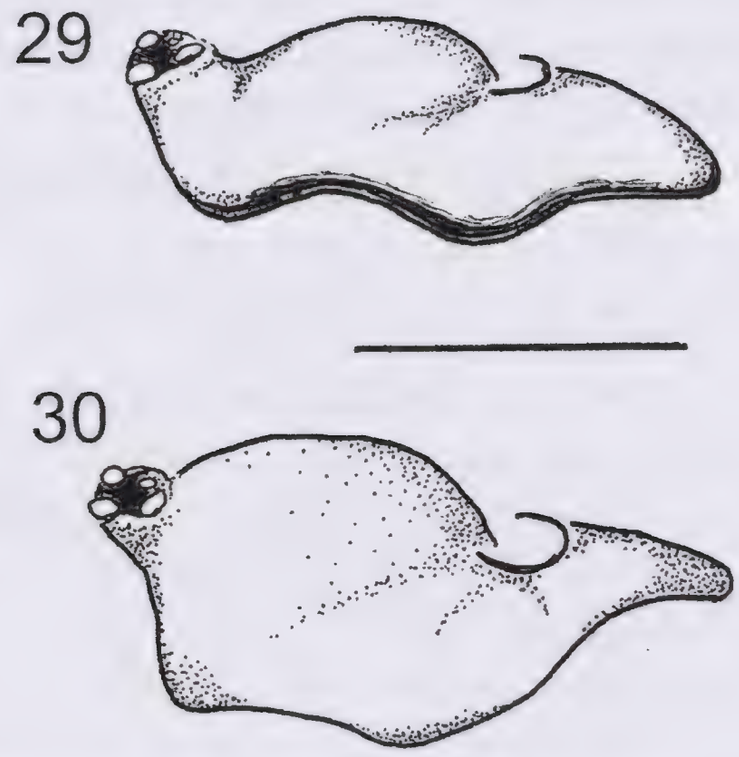
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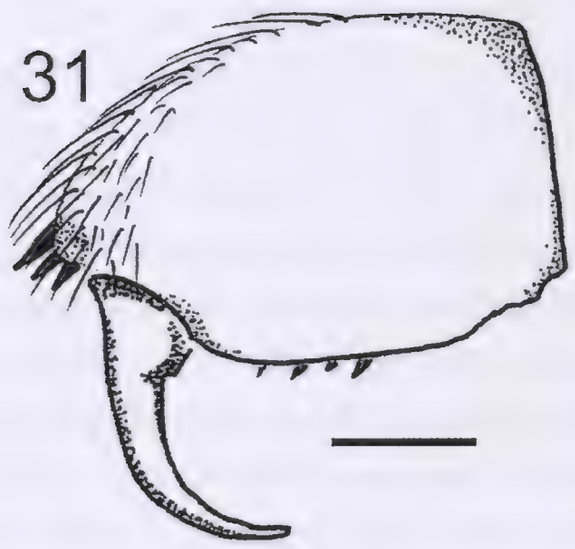
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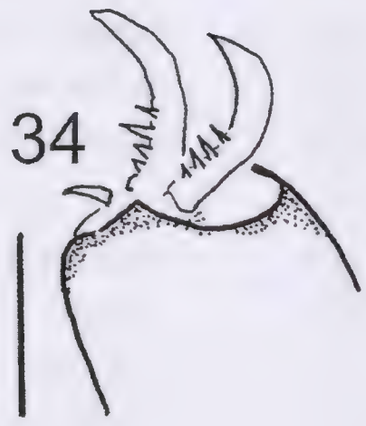
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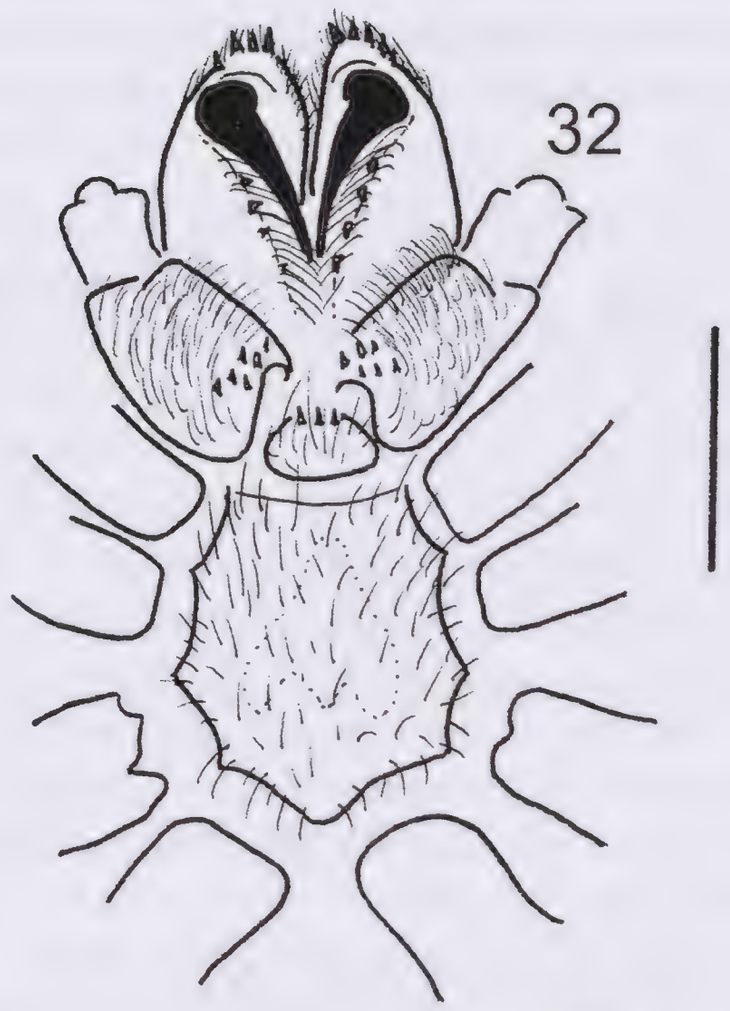
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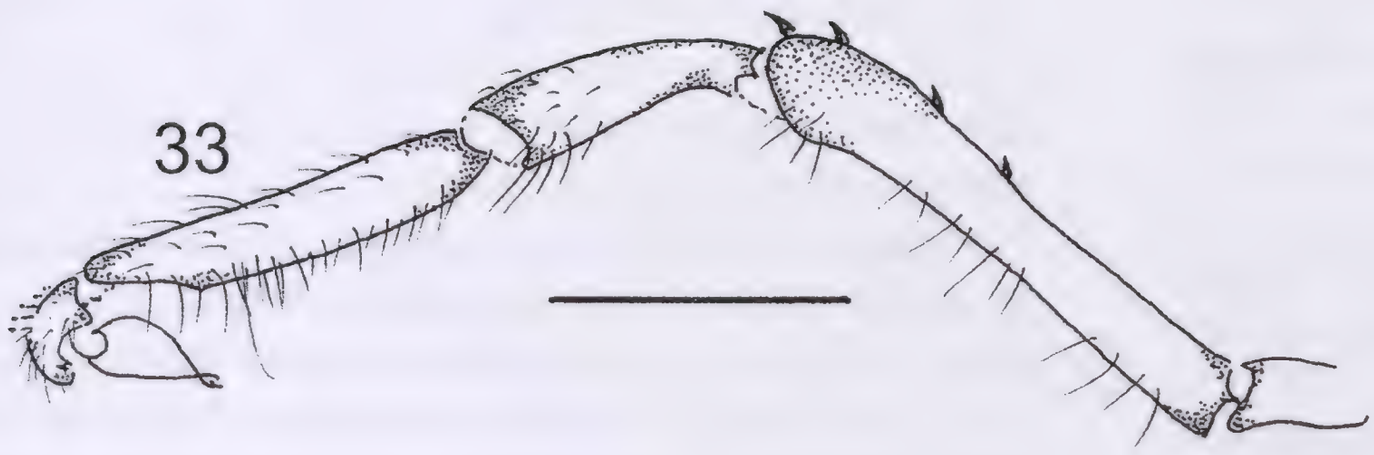
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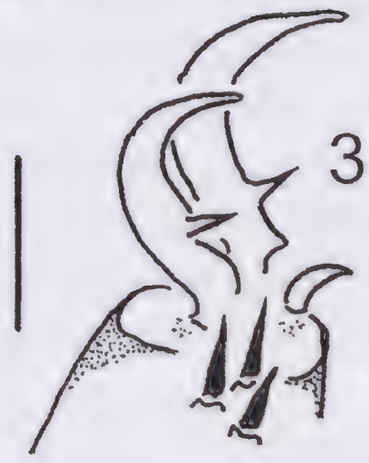
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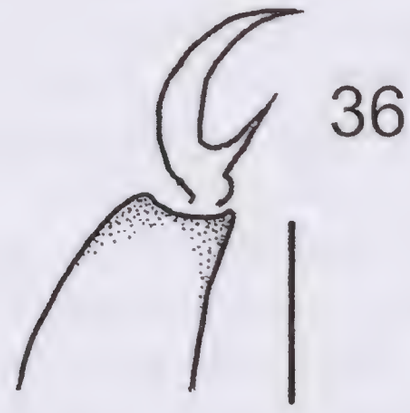
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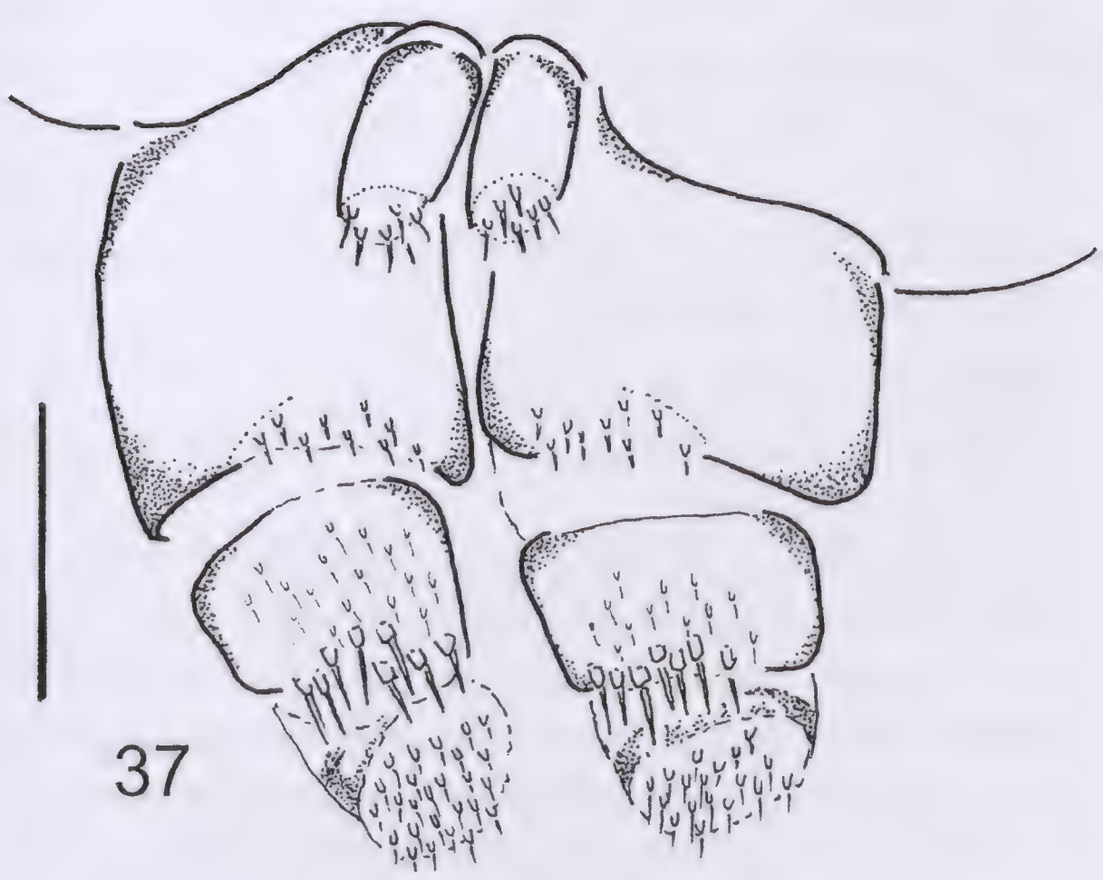
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PS-017); Vietnam, Kien Giang Province, Nui Hang Tien, Hang Tien, north of Hong Chong; WGS84 10.18867, 104.59611; altitude 1 m (inside limestone cave); 11.08.2003; leg. P. J. Schwendinger.

Etymology: This species is named after Peter J. Schwendinger who collected and raised the type specimens and made them available for this study.

Diagnosis: This species is distinguished from all known *Latouchia* species, for which sufficient information is available, by its small size as measured by the length of the carapace. Male CL 3.9 in *L. schwendingeri* sp. nov. versus an average male CL of 6.1 (SD = 0.8) in eight *Latouchia* species reported on in the literature. Females CL 4.3 in *L. schwendingeri* sp. nov. versus an average female CL of 6.9 (SD = 1.8) in fifteen *Latouchia* species reported in the literature. The male furthermore differs from males described and illustrated in the literature (Pocock, 1901; Strand, 1907, 1910; Schenkel, 1953, 1963; Song & Hu, 1982; Song *et al.*, 1983; Haupt & Shimojana, 2001; Song *et al.*, 2001; Tso *et al.*, 2003; Ono, 2010), by an elongated proximal part of the bulb and by a short embolus with a bent 'nose-like' tip (Figs 23-26). Females differ from all known females of *Latouchia* species, with the exception of *L. huberi* sp. nov. described below, by the multilobed, 'berry-like' receptacles of the spermathecae (Figs 38-39). Females of *L. schwendigeri* sp. nov. differ from those of *L. huberi* sp. nov. by the very short, dome-shaped receptacles of the spermathecae (compare Figs 38-39 with Figs 46-47) and by leg III being distinctly longer than leg II.

Description of male (holotype)

Colouration: Carapace uniformly dull dark brown; abdomen dorsally almost uniformly light grey, with a faintly lighter zone in cardiac region, ventrally light grey, slightly yellowish; chelicerae uniformly brown; sternum and ventral side of leg coxae light brown; labium and maxillae darker brown; PMS creamy white, PLS light yellowish; legs generally light brown, proximally slightly darker than distally; palps slightly darker brown than legs, dorsal side of femora of all limbs dark brown, generally ranging from brown proximally to light yellow distally.

Carapace (Figs 27, 29): Roundish in dorsal view, slightly longer than wide (w/l = 0.9), with thickened rim around lateral and caudal margins, texture of cuticle finely granular, wrinkled along the edges, glabrous except for few fine bristles on cephalic part. Fovea procurved and regularly crescent-shaped, with thickened posterior rim. Cephalic part regularly curved upward, with a narrow depression directly posterior of eye group, thoracic part of carapace gradually curving downward from fovea (Fig. 29). Clypeus narrow; ocular process almost touching anterior carapace edge. Eye group twice as wide as long (EL/PR = 0.5), slightly trapezoidal, PR slightly wider than AR (AR/PR = 1.06), AME on low mound, anterior eyes grey, posterior eyes pearly white.

Chelicerae (Fig. 31): Dorsally with two wide glabrous zones separated by longitudinal bands with fine bristles, these distally merging with a field of stronger bristles and apical rastellar teeth; ventral fang groove dentate along both edges, teeth in both rows separated and irregularly arranged; fang long and sharp; rastellar teeth on a low mound.

Ventral side of cephalothorax: Sternum slightly longer than wide (w/l = 0.9), roughly oval in shape, widest between coxae II and III, sigilla indistinct. Labium wider than long (w/l = 1.2), roundish, dome-shaped, without cuspules. Maxillae roughly rectangular, without cuspules or distal prolateral heel.

Palps (Fig. 33): Tibia and femur strongly elongated. Cymbium dorsally with small group of 4-5 clavate trichobothria, spines absent. Femur with curved, short, thorn-like spines dorsally in distal half of segment. Bulb (Figs 23-26) with proximal part pyriform (Fig. 24), longer than embolus. Embolus proximally wide, medially abruptly narrowing (Fig. 23), distally bent, with a 'nose-shaped' part extending beyond sperm duct pore (best seen in ventral and dorsal views, Figs 23, 25).

Legs: Tarsi spineless, spines present on all other segments, trochanter spines small. Leg I with strong spines on the prolateral side of patella, on prolateral and ventral side of tibia and on ventral side of metatarsus; patella III with spines on all sides and with a distinctive transverse spine row along dorsodistal margin. Tarsi I and II with thin scopula (absent from tarsi III and IV), few clavate trichobothria dorsally in proximal half of segment (absent from tarsus IV).

Paired claws: Anterior legs with short rows of 3-4 teeth grouped together (Fig. 34), posterior legs with rows of only 1-2 teeth; third claw small, unarmed and curved.

Abdomen: Ovoid in dorsal view, soft, with fine bristles evenly spaced.

Spinnerets: As in female (see below).

Measurements: TBL 9.8; CL 3.9; CW 3.5; CP 2.2; AR 0.78; PR 0.83; EL 0.39; dALE 0.26; dPLE 0.14; dAME 0.13; dPME 0.13; diAME 0.07; diPME 0.23; SL 2.1; SW 1.8; LL 0.6; LW 0.8; MaxL 1.4; PaL 8.9 (0.6 + 2.7 + 2.0 + 3.6); LL1 12.7 (1.2 + 2.7 + 2.7 + 2.0 + 4.1); LL2 11.6 (1.2 + 2.6 + 2.4 + 1.7 + 3.7); LL3 11.0 (1.5 + 2.9 + 1.9 + 1.6 + 3.1); LL4 14.0 (1.6 + 3.7 + 3.0 + 1.7 + 4.0) BuL 1.01; BuW 0.41; EmL 0.37.

Description of female (allotype)

Colouration: Carapace yellow, abdomen light grey, other body parts as in male.

Carapace (Figs 28, 30): Cuticle smooth, with few bristles of very different lengths and strengths widely distributed over cephalic part and with very few fine bristles on thoracic part. Cephalic part elevated, curving upward from ocular mound before descending steeply down to fovea (Fig. 30). Thoracic part almost straight, gently

sloping down from fovea to posterior carapace margin. Fovea procurved, slightly recurving at both ends.
Chelicerae: Stronger than in male; rastellum with four strong apical teeth in a transverse row on a distinct elevation; parallel rows of strong teeth on each side of fang groove.
Ventral side of cephalothorax (Fig. 32): Sternum as in male (SW/SL = 0.9). Labium as in male, but with small group of two to three apical cuspulus. Maxillae, as in male, prolateral distal heel absent, with groups of about 14 sharp pointed cuspules along proximal margin.
Palps: Tarsus with dorsal groups of 7 clavate trichobothria, tarsus and tibia with dense lateral groups of mainly curvy spines over entire lengths of segments (as illustrated for *L. huberi* sp. nov. in Fig. 43), tarsal claw smooth or with one sharp proximal tooth (Fig. 36).
Legs: Posterior two pairs of legs stronger than anterior two pairs, tarsal clavate trichobothria as in male, distal two segments of legs I and II with bands of spines on their lateral surfaces (as illustrated for *L. huberi* sp. nov. in Fig. 44), more dorsally situated spines in these groups short and curvy, more ventrally situated spines longer and straight; bands of spines on tibiae reduced. Spines on patella and metatarsus III situated dorsally; no trochanter spines as in male, but long bristles instead.
Paired claws (Fig. 35): With single proximal tooth (reduced on leg IV).
Abdomen: Larger than in male.
Spinnerets: PMS digitiform, with few fine distal spigots. PLS with macrospigots only distally on median segment (Fig. 37). Proximal segment as wide as long, cylindrical, with few fine distal spigots; median segment short, with double row of distal macrospigots; distal segment very short, knob-shaped, with apical field of fine spigots.
Spermathecae (Figs 38-39): Monopartite, very short, dome-shaped, with numerous vesicles on surface giving them a raspberry-like appearance.
Measurements (allotype): TBL 14.2; CL 4.3; CW 3.6; CP 2.7; AR 0.84; PR 0.89; EL 0.62; dALE 0.24; dPLE 0.17; dAME 0.12; dPME 0.17; diAME 0.08; diPME 0.31; SL 2.6; SW 2.2; LL 0.7; LW 0.9; MaxL 1.6; PaL 8.0 (1.7 + 1.8 + 1.7 + 2.8); LL1 8.6 (0.9 + 1.3 + 1.7 + 1.8 + 2.9); LL2 7.4 (0.9 + 1.1 + 1.4 + 1.6 + 2.4); LL3 8.0 (1.2 + 1.4 + 1.1 + 1.8 + 2.5); LL4 10.5 (1.3 + 2.0 + 2.1 + 1.9 + 3.2); Int 0.24; Ext 0.63.
Measurements (paratype): TBL 12.9; CL 4.2; CW 3.6; CP 2.7; AR 0.77; PR 0.83; EL 0.40; dALE 0.26; dPLE 0.17; dAME 0.12; dPME 0.14; diAME 0.06; diPME 0.32; SL 2.4; SW 2.2; LL 0.7; LW 0.9; MaxL 1.4; PaL 7.3 (1.6 + 1.6 + 1.5 + 2.6); LL1 7.8 (0.9 + 1.1 + 1.4 + 1.7 + 2.7); LL2 6.6 (0.8 + 1.0 + 1.1 + 1.4 + 2.3); LL3 7.4 (1.1 + 1.3 + 1.1 + 1.6 + 2.3); LL4 9.5 (1.2 + 1.7 + 1.9 + 1.8 + 2.9); Int 0.30; Ext 0.66.

Biology: The specimens examined were collected from burrows dug into the loamy floor of a limestone cave at the coast. The cave itself was not flooded during high tide, but its surroundings were. The burrows were distinctly longer than the spider inhabitants and equipped with a single, thick, cork-shaped trapdoor. Several burrows were found close to each other, which is unusual for SE-Asian Ummidiinae.

***Latouchia huberi* sp. nov.**

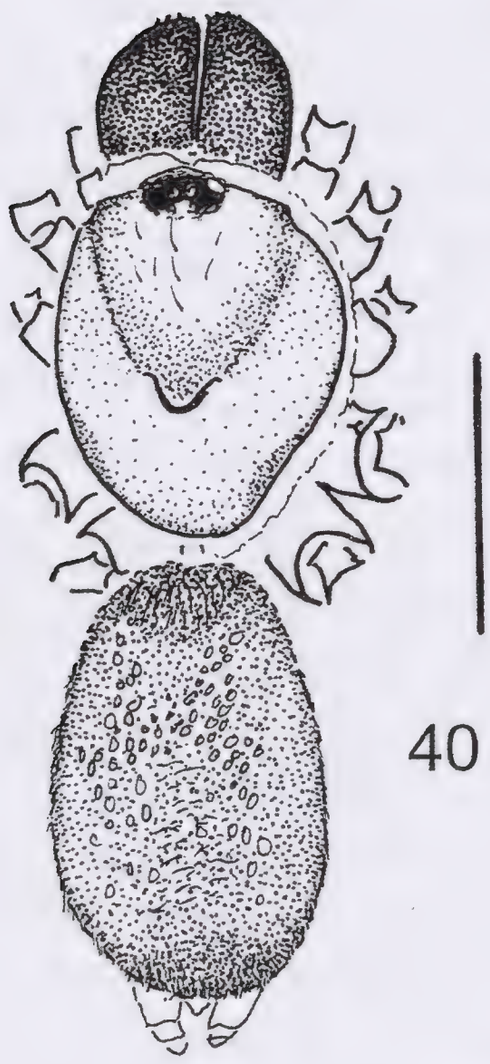
Figs 40-47, 52

Types: MHNG, sample SV-03/04; female holotype (ID: PS-020), 3 female paratypes (ID: PS-018, PS-019, PS-021, PS-023); Vietnam, Kien Giang Prov., Mui Nai Beach; WGS84 10.37856, 104.44864; altitude 5 to 50 m; 10.08.2003; leg. P. J. Schwendinger.

Etymology: The species is named after Siegfried Huber (Mühlhofen, Germany), an expert collector of cryptozoic arachnids, several of which belong to species new to science.

Diagnosis: Females are very similar to those of *L. schwendingeri* sp. nov. described above, but different in the, on average, larger size of adult females (CL 5.7, SD = 0.5, n = 5 versus CL 4.2-4.3, n = 2 in *L. schwendingeri* sp. nov.), in the distinctly darker coloured abdomen (compare Fig. 40 with Fig. 28 and Fig. 52 with Fig. 51), in the relative lengths of leg II and leg III (see diagnosis of *L. schwendingeri* female above) and in the longer, straight, tube-shaped receptacles of the spermathecae (Figs 46-47).

Description of female (holotype)
Colouration: Carapace brown, thoracic part slightly lighter than cephalic part, abdomen dorsally uniformly dark grey, ventrally light grey, chelicerae uniformly dark brown, sternum and ventral side of leg coxae yellowish brown, labium and maxillae darker brown, PMS light grey, PLS light yellowish, legs generally light brown, ventrally yellowish.
Carapace (Figs 40-41): Longer than wide (CW/CL = 0.8), posteriorly narrowing, cuticle smooth, glabrous except for some fine bristles on elevated cephalic part. Cephalic part only slightly rising behind ocular process and then descending steeply to fovea (Fig. 41), thoracic part gradually descending from fovea to posterior carapace margin. Fovea procurved, slightly recurving at both ends.
Chelicerae: Rastellum composed of strong teeth grouped on a distinct process; parallel rows of strong, teeth along sides of fang groove; teeth in retrolateral row strongest.
Ventral side of cephalothorax (Fig. 42): Sternum longer than wide (SW/SL = 0.9). Sigilla fused, impression indistinct. Labium cone-shaped, anteriorly truncated, proximally wider than long (LW/LL = 1.3), apically with a group of three sharp pointed cuspules. Maxillae roughly rectangular, with distinct proximal 'heel' and with groups of 10-12 sharp pointed cuspules along proximal margin, distal prolateral heel absent.



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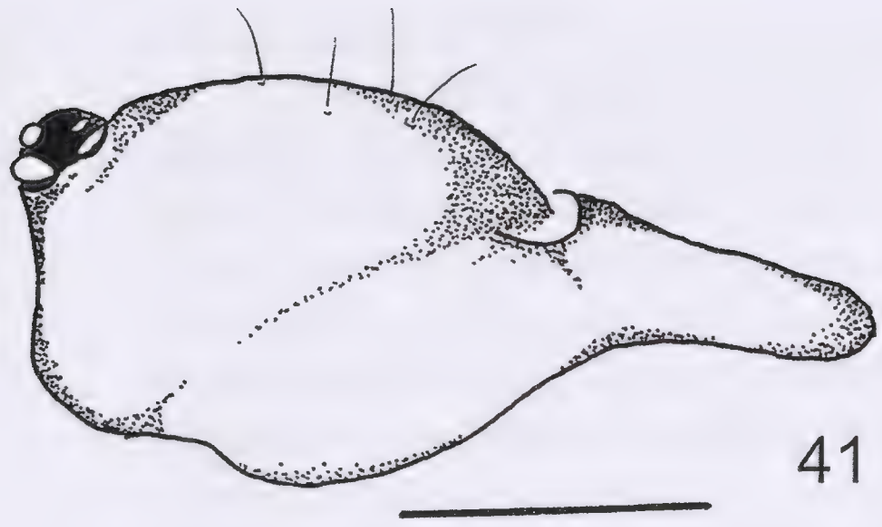

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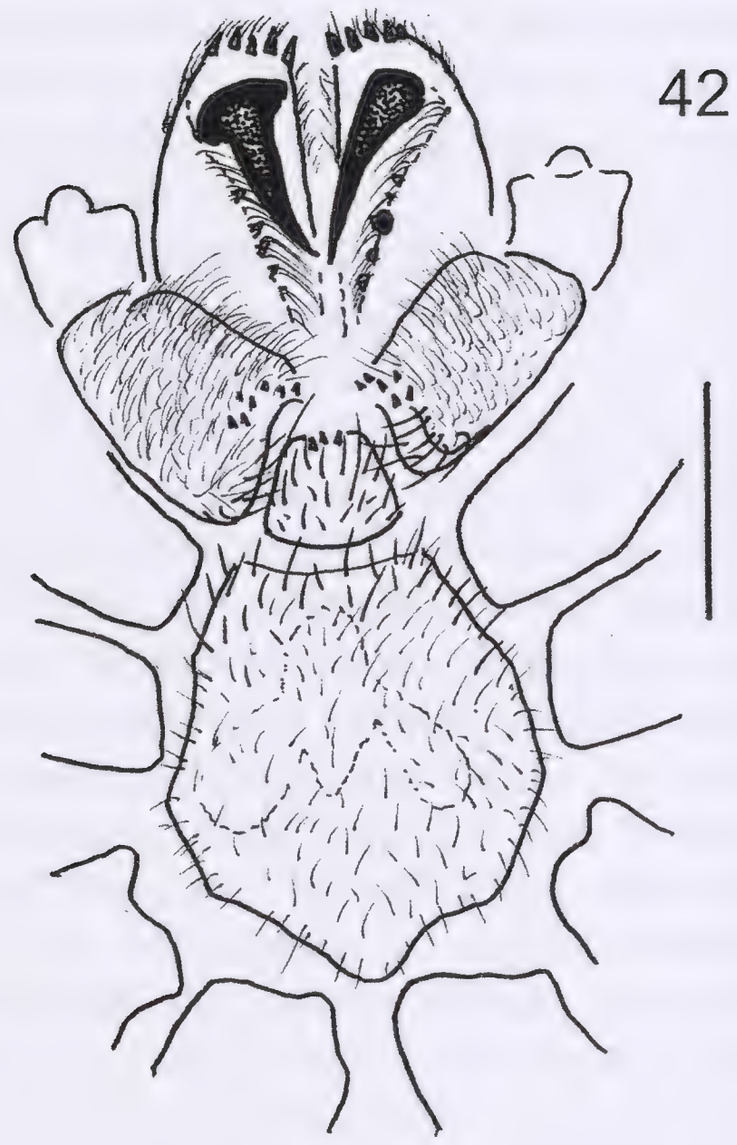

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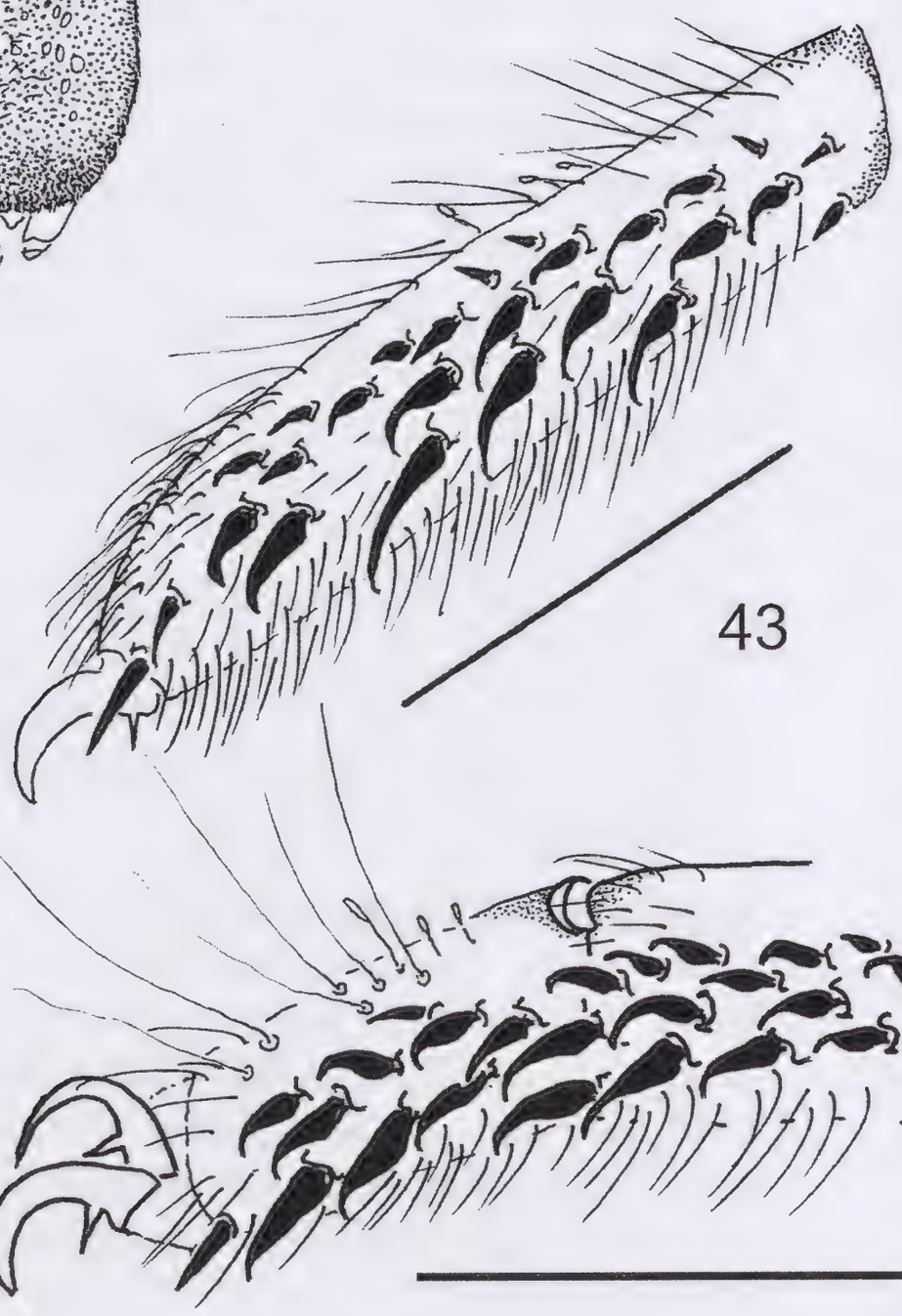

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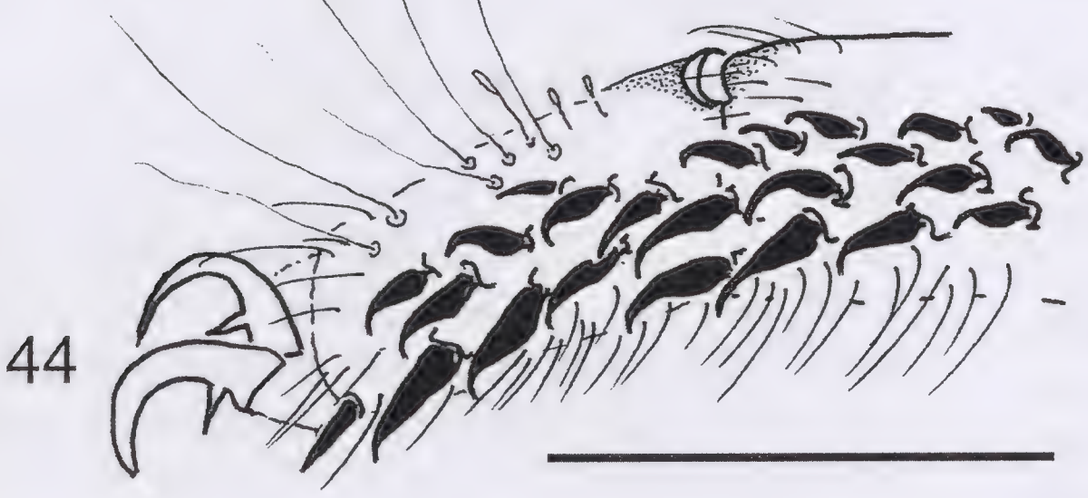

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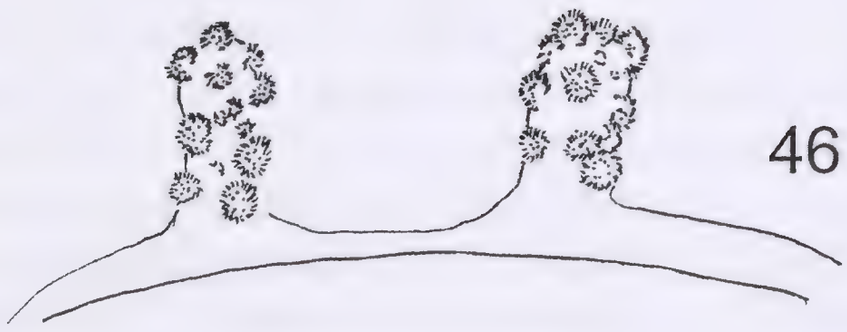

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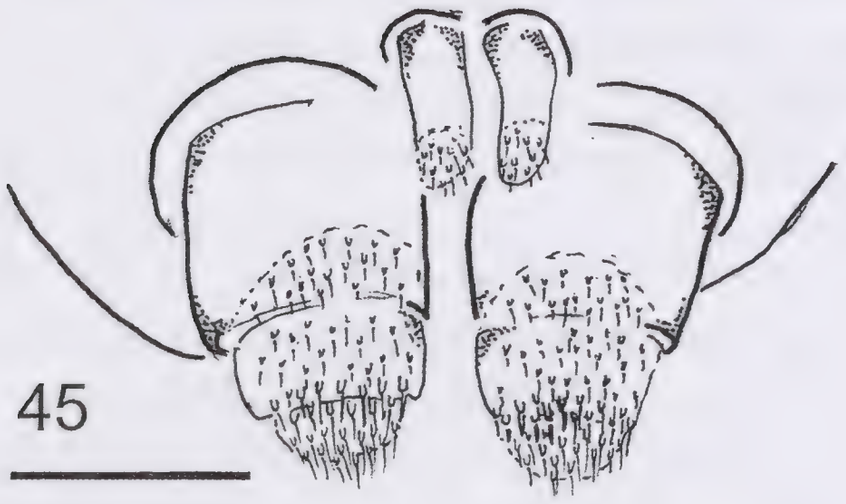

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Figs 40-47. *Latouchia huberi* sp. nov. (40) Dorsal habitus of female holotype (ID: PS-020). (41) Lateral aspect of carapace of female. (42) Ventral Cephalothorax of female (note indistinctly fused central sigilla). (43) Left palp tarsus of female in retrolateral view (note dense field of curvy spines over entire length of segment). (44) Distal end of leg I of female in retrolateral view (note dense fields of curvy spines, single claw tooth and clavate trichobothria on dorsal side of tarsus). (45) Spinnerets of female holotype in ventral view. (46) Spermathecae of female holotype (ID: PS-020) in ventral view. (47) Spermathecae female paratype (ID: PS-021) in ventral view. Scale lines with number of millimetres between parentheses: Figs 40-41 (5); Fig. 42 (2); Figs 43-47 (1).

Figs 48-49. *Latouchia stridulans* sp. nov., dorsal habitus of specimens as studied submerged in 70% ethanol. (48) Male holotype, (49) Female allotype. Scale bars 2 mm.

Figs 50-51. *Latouchia schwendingeri* sp. nov. dorsal habitus of specimens as studied submerged in 70% ethanol. (50) Male holotype, scale bar 1 mm. (51) Female allotype, scale bar 2 mm.

Fig. 52. *Latouchia huberi* sp. nov. dorsal habitus of specimen as studied submerged in 70% ethanol. Female holotype, scale bar 2 mm.

Palp: Tarsus (Fig. 43) with dorsal groups of 4-5 clavate trichobothria, tarsus and tibia with dense lateral bands of mainly curvy spines over entire lengths of segments, tarsal claw with small proximal tooth.
Legs: Posterior two pairs of legs stronger than anterior two pairs, with few clavate trichobothria proximally on tarsi I (Fig. 44) and II, reduced on tarsus III and absent from tarsus IV. Distal two segments of legs I and II with bands of spines on their lateral surfaces (Fig. 44), more dorsal spines in these groups short and curvy, more ventral spines longer and straight, tibial spine groups restricted to distal half of segment. Spines on patella and metatarsus III situated dorsally, trochanter without modifications.
Paired claws (Fig. 44): With single proximal tooth (smaller on claws of leg IV).
Abdomen: Ovoid, evenly covered with fine bristles, few larger bristles in anterior part of dorsal area.
Spinnerets: PMS digitiform, with few fine distal spigots. PLS with macrospigots only distally on median segment (Fig. 45). Proximal segment as wide as long, cylindrical, with few fine distal spigots; median segment short, with double row of distal macrospigots; distal segment very short, knob-shaped, with apical field of fine spigots.
Spermathecae (Figs 46-47): Monopartite, two column-shaped receptacles almost parallel to each other, with numerous berry-like vesicles.
Measurements (holotype): TBL 16.4; CL 6.2; CW 5.0; CP 3.9; AR 1.08; PR 1.12; EL 0.58; dALE 0.37; dPLE 0.24; dAME 0.14; dPME 0.18; diAME 0.14; diPME 0.40; SL 3.6; SW 3.2; LL 0.9; LW 1.2; MaxL 2.2; PaL 10.3 (2.1 + 2.3 + 2.3 + 3.6); LL1 11.0 (1.0 + 1.6 + 2.2 + 2.5 + 3.7); LL2 9.8 (1.1 + 1.5 + 1.8 + 2.2 + 3.2); LL3 9.7 (1.4 + 1.8 + 1.3 + 2.2 + 3.0); LL4 12.9 (1.5 + 2.6 + 2.4 + 2.6 + 3.8); Int 0.35; Ext 0.63.
Variation in measurements of females (n = 4): TBL 13.7-16.4; CL 5.0-6.2; CW 4.3-5.0; CP 3.2-3.9; AR 0.90-1.08; PR 0.98-1.12; EL 0.51-0.58; dALE 0.29-0.37; dPLE 0.18-0.24; dAME 0.12-0.14; dPME 0.15-18; diAME 0.11-0.14; diPME 0.32-0.41; SL 3.1-3.6; SW 2.7-3.2; LL 0.9; LW 1.1-1.2; MaxL 1.9-2.2; PaL 9.0-10.3; LL1 9.3-11.0; LL2 8.2-9.8; LL3 8.5-9.7; LL4 10.9-12.9; Int 0.25-0.35, Ext 0.55-0.63.

Biology: The type specimens were collected from earthbanks along a road near the coast, where such spiders appeared to be quite abundant (unusual for SE-Asian Ummidiinae). Their burrows were quite long (5-8 cm) and equipped with a single, cork-shaped trapdoor, much like in *L. schwendingeri* sp. nov.

DISCUSSION

Within the Rastelloidina (i.e. mygalomorph spiders carrying a distinct rastellum at the apex of the proximal segment of the chelicerae), the Ummidiinae are remarkable in several aspects. In phylogenetic analysis they form a distinct taxon containing three genera: *Ummidia*, *Conothele* and *Latouchia* (Godwin *et al.*, 2018). Morphologically Ummidiinae differ from all other rastelloids by the presence of clavate trichobothria on the dorsal side of the tarsi of legs and palps. Clavate trichobothria however, are also present in the rastelliod/idiopid genus *Prothemenops*, but in contrast to the ummidines, here clavate trichobothria are located on the metatarsi of legs and on the tarsi of the palps Schwendinger (1991), Schwendinger & Hongpadharakiree (2014). In their geographical distribution the Ummidiinae deviate from the common pattern of regionally restricted geographical ranges seen in nearly all mygalomorph taxa. The sister genera *Ummidia* and *Conothele* are morphologically and behaviourally indistinguishable (personal observation) and together show an almost cosmopolitan distribution. *Ummidia* is known from the Americas, southern Europe, northern Africa and Central Asia, *Conothele* is known from India, Southeast Asia, Australia and several islands in the Pacific and in the Indian Ocean. The remarkable worldwide uniformity of ummidiines is interrupted only in southeastern Asia where *Conothele* occurs sympatrically with the morphologically distinct genus *Latouchia*. From observations reported here it is obvious that ummidiine diversity in southeastern Asia is currently insufficiently known and it is expected that unknown genera await description. The substantial morphological difference found here between *L. stridulans* sp. nov. on one hand and *L. schwendingeri* sp. nov. and *L. huberi* sp. nov. on the other hand indicate the necessity to subdivide the genus *Latouchia* into two or more genera. Above reported differences in the structure of burrows and trapdoors provide further support for the division of the genus. The absence of reference material at this stage however, prevents further taxonomical refinement.

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A new species of *Oochoristica* (Cyclophyllidea, Anoplocephalidae) from *Varanus albigularis* (Squamata, Varanidae) in Kenya

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Abstract: *Oochoristica varanicola* sp. nov. (Anoplocephalidae, Linstowiinae) is described from *Varanus albigularis* in Kenya. It is the third species of this cestode genus described from monitor lizards. *Oochoristica varanicola* differs from other species from *Varanus*, as well as from the numerous other species in the genus by a unique combination of characters that include a high number of testes (92-134) and a long cirrus-sac (225-290 x 63-90 µm). Both the host and the locality are new records for the genus *Oochoristica*.

Keywords: Parasites - Platyhelminthes - Cestoda - Linstowiinae - Reptilian hosts - Monitor lizards - Africa.

INTRODUCTION

Herein we describe a new cestode from the white-throated monitor *Varanus albigularis* (Daudin, 1802), collected south of Lake Turkana in the Rift Valley Province of Kenya. Species of *Oochoristica* Lühe, 1898 are commonly encountered in reptiles worldwide and about 100 species are presently known (McAllister & Bursey, 2017). Only a very few have, however, been reported from monitor lizards.

MATERIAL AND METHODS

This material was given to us by Dr M. Jirků (České Budějovice, Czech Republic) who collected it during fieldwork in the Lake Turkana area in 2006. A single *V. albigularis*, killed by a cobra, was examined. After dissection, the worms were relaxed in physiological saline, then fixed in hot 4% formaldehyde, and finally transferred to 70% ethanol. They were stained in Mayer's hydrochloric carmine, dehydrated in an ethanol series, cleared in eugenol and mounted in Canada balsam. The slides were examined with a Nikon Eclipse-80i microscope equipped with Nomarski interference contrast optics. Drawings were made with a drawing tube. Photographs were taken on the same microscope with a Jenoptik camera and treated with Progres Gryphax 1.1.8 software©. All measurements are expressed in micrometers unless otherwise indicated. Metric and meristic values are presented as the range followed by their mean and the number of measurements made in parentheses.

Abbreviations. MHNG-PLAT: Natural History Museum of Geneva, Platyhelminthes collections. BMNH: British Museum (Natural History), London.

TAXONOMIC PART

Oochoristica varanicola sp. nov.

Figs 1-5

Material examined

Holotype: MHNG-PLAT-124881; 1 complete specimen. Host: *Varanus albigularis* (Daudin, 1802), Varanidae, Squamata. Site: Small intestine. Locality: About 20 km North of South Horr, Marsabit County, Kenya. 2 16 32.91°N 36 53 6.07°E. Date: 2006. Collector: Miloslav Jirků. Field number: MJ-C-6-06.

Paratypes: MHNG-PLAT-124882; 5 complete specimens. Collection data as for holotype.

Comparative material: MHNG-PLAT-45464; *Oochoristica rostellata* Zschokke, 1905 from *Cerastes cornutus* Boulenger, 1896, Bou Saâda, Algeria, 5.1926. – MHNG-PLAT-45463; *Oochoristica rostellata* from a colubrine snake, Algeria, 1935. – BMNH 1919.11.22.17-19; *Oochoristica zonuri* Baylis, 1919 from *Cordylus*

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tropidosternum (Cope, 1869) (=*Zonurus tropidosternum* Cope, 1869), Mozambique ("Portuguese East Africa"), type material. – MHNG-PLAT-41351 and 41352; *Oochoristica cryptobothrium* (von Linstow, 1906), from *Chrysopelea ornata* (Shaw, 1802), Kurunegala, Sri Lanka, syntypes. – BMNH 1977.11.3.15-16; *Oochoristica cryptobothrium* from a lizard from Accra, Ghana.

Etymology: The species name refers to generic name of the host.

Description

Cyclophyllidea: Anoplocephalidae. Body small, up to 12.3 mm long. Average width about 1.5 mm, maximum width 1.8 mm at level of early gravid proglottides. Up to 182 proglottides. Proglottides acraspedote, wider than long, becoming square at postmature level and progressively elongating to about 1.5 to 1.7 times longer than wide when fully gravid. Scolex rounded, massive, not delineated from neck, 670-800 (736, n=6) in diameter (Fig. 1). Suckers rounded to oval 250-310 x 205-270 (286 x 237, n=24) strong, muscular, unarmed. Rostellar apparatus lacking. Proglottization distinct about 1.5 mm behind posterior margin of suckers. Genital pores situated in anterior 25-30% of lateral proglottis margin, irregularly alternating, usually in short series, e.g. … 4, 2, 2, 2, 1, 1, 4, 2, …, but occasional long unilateral series possible (up to 13 consecutive pores observed on a single side). Ventral osmoregulatory canals up to 80 wide, connected posteriorly in each proglottis by complex, reticular, transverse anastomosis across testicular field (Fig. 2). Dorsal osmoregulatory canals 11-27 wide, overlying ventral canals. Genital ducts passing between osmoregulatory canals in most proglottides but occasionally also dorsal (all specimens show several proglottides with dorsal genital ducts). Genital atrium large, 80-112 (97, n=31) deep; surrounded by a compact layer of glandular cells. Atrium sometimes evaginating to form crateriform protrusion (observed in gravid proglottides).

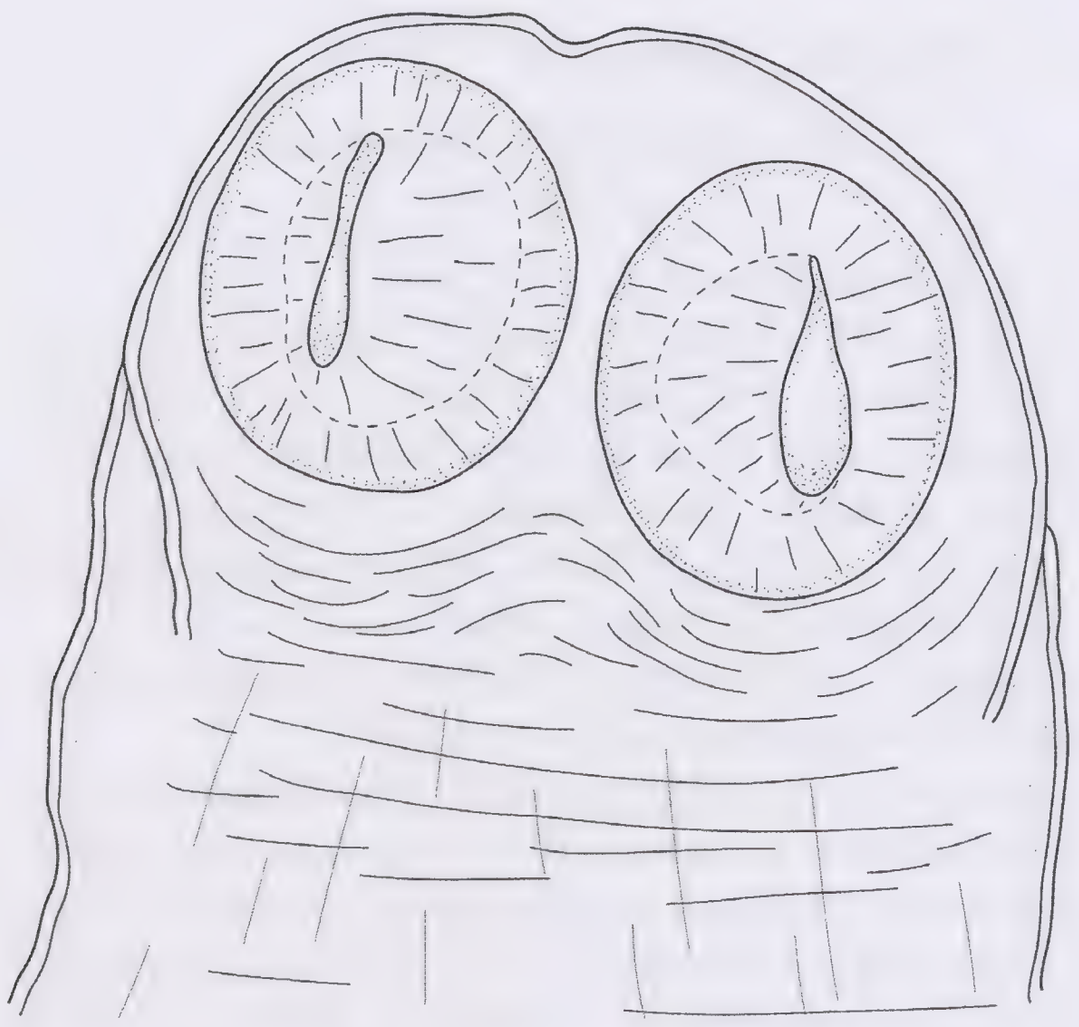

Fig. 1. *Oochoristica varanicola* sp. nov. Scolex. Scale bar: 250 µm.

Testes 92-134 (109, n=27) in number; in one or occasionally two layers, in one continuous posterior field, extending on lateral sides of proglottis to anterior extremity of vitellarium, and antero-porally to posterior level of ovary, often overlapping, or even external to, osmoregulatory canals. External vas deferens convoluted, surrounding proximal extremity of cirrus-sac. Cirrus-sac thick-walled, triangular, widest at its truncated distal extremity, 225-290 x 63-90 (255 x 79, n=56); extending just beyond osmoregulatory canals. Long retractor muscles attached at its proximal tip. Cirrus and internal vas deferens forming several coils. Cirrus unarmed (Fig. 3).

Vitellarium central and poral, more or less densely multilobed, often with detached lobes scattered among testes, highly variable in shape. Ovary antero-poral, bilobate, multilobulate, with deeply separated irregular lobules, about 14-20 lobules in total. Seminal receptacle small, elongated between ovarian wings. Vagina opening posteriorly to male pore, runs transversely, parallel to cirrus-sac, but often making curve or loop at mid length of cirrus-sac and often turning sharply anteriorly at level of opening into genital atrium (Fig. 3) surrounded by regular sheath of large rounded cells; sphincter absent.

Uterus appearing antero-ventrally and centrally as small cavity, quickly transforming into a discrete labyrinthine, thin-walled network, developing posteriorly to middle of proglottis and progressively disappearing. Eggs developing in parenchyma, and occupying entire median and lateral fields, in one continuous field across many proglottides. Fully developed eggs in large, thin walled capsules, 75-100 (89, n= 35) in diameter; entirely filling terminal gravid proglottides (Fig. 4). Oncospheres 27-36 in diameter (30.5, n=50) surrounded by irregular inner membrane. Central embryonic hooks 18-20 (19, n=27) long; thin with straight blade; lateral hooks shorter 16-18 (17, n=32); inner lateral hooks of lateral pair more massive with stronger guard than outer hooks (Fig. 5).

REMARKS

Our material belongs to the genus *Oochoristica* Lühe, 1898, a taxon with a complex history as summarized e.g. in Hughes (1940); Spasskii (1951); Della Santa (1956); Beveridge (1994, 2008); or Masová *et al*. (2012). The most recent generic diagnosis (Beveridge, 1994) has been subsequently emended by Masová *et al*. (2012) for a number of minor details as well as removing the

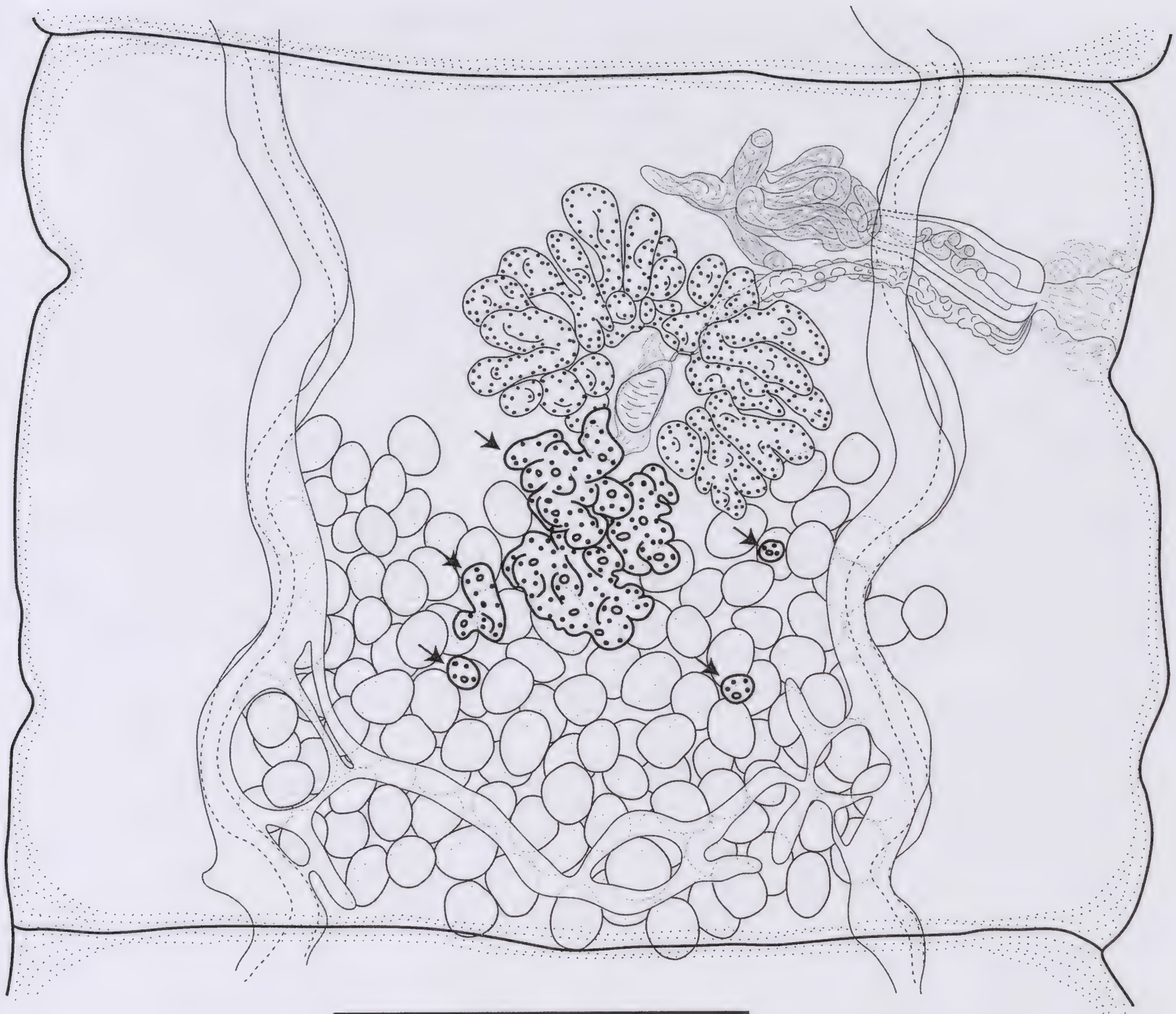

Fig. 2. *Oochoristica varanicola* sp. nov. Mature proglottis. Ventral view. Note the multilobed vitellarium (arrows). Scale bar: 500 µm.

acraspedote nature of proglottides as a generic character. This latter character however would imply the synonymy of *Mathevotaenia* Akhumyan, 1946, whose members are primarily parasites of mammals, with *Oochoristica*, found essentially in reptiles (although exceptions do exist) (Beveridge, 1994). Although certainly needing investigation, this character is the single feature allowing separation of both genera. We thus consider here the genus *Oochoristica sensu* Beveridge, 1994, and accept only part of the emendation of Masová *et al*. (2012) in recognizing that testes can also be lateral to the vitellarium in some species.

A recent list, including almost 100 valid species of *Oochoristica,* was provided by McAllister & Bursey (2017), who also listed selected major discriminating characters for these species. In their table, these authors list eight species from the Afrotropical region. To our knowledge no other species in this genus has been described more recently.

Although the genus is widely diversified in the Squamata, especially in the Lacertilia, only two species of *Oochoristica* have been reported from Varanidae. *Oochoristica varani* Nama & Khichi, 1972 was found in Jodhpur (Rajasthan) in "*Varanus monitor*", a taxon which does not exist: the authors most likely referring to *V. bengalensis* (Daudin, 1802) the common local monitor, or, possibly, to *V. flavescens* (Hardwicke & Gray, 1827) although this species is morphologically quite distinct and would probably have been correctly identified. *Oochoristica varani* can easily be distinguished from our material by its smaller scolex (270-412 µm) and suckers (150-200 x 140-170 µm), shorter cirrus-sac (140-210 µm) and lower number of testes (40-55) (Nama & Khichi, 1972).

Oochoristica tuberculata (Rudolphi, 1819) has been reported from a number of lizards, mostly Lacertidae, Scincidae and Agamidae (Della Santa, 1956), but also from *V. griseus* (Daudin, 1803), in Tunisia (Joyeux, 1923) and in Iran (Dollfus, 1965). Those reports should however be considered with caution as the Tunisian material is composed of a few young specimens that were only tentatively attributed to *O. truncata*, and the Iranian material is composed of "quelques débris en mauvais état" (several fragments in a poor state (of preservation) that "il est possible que l'on puisse rapporter les débris... à... *O. tuberculata*" (may possibly be attributed to *O. truncata*). The presence of this species in *Varanus* is thus highly questionable. In any case, *O. tuberculata*

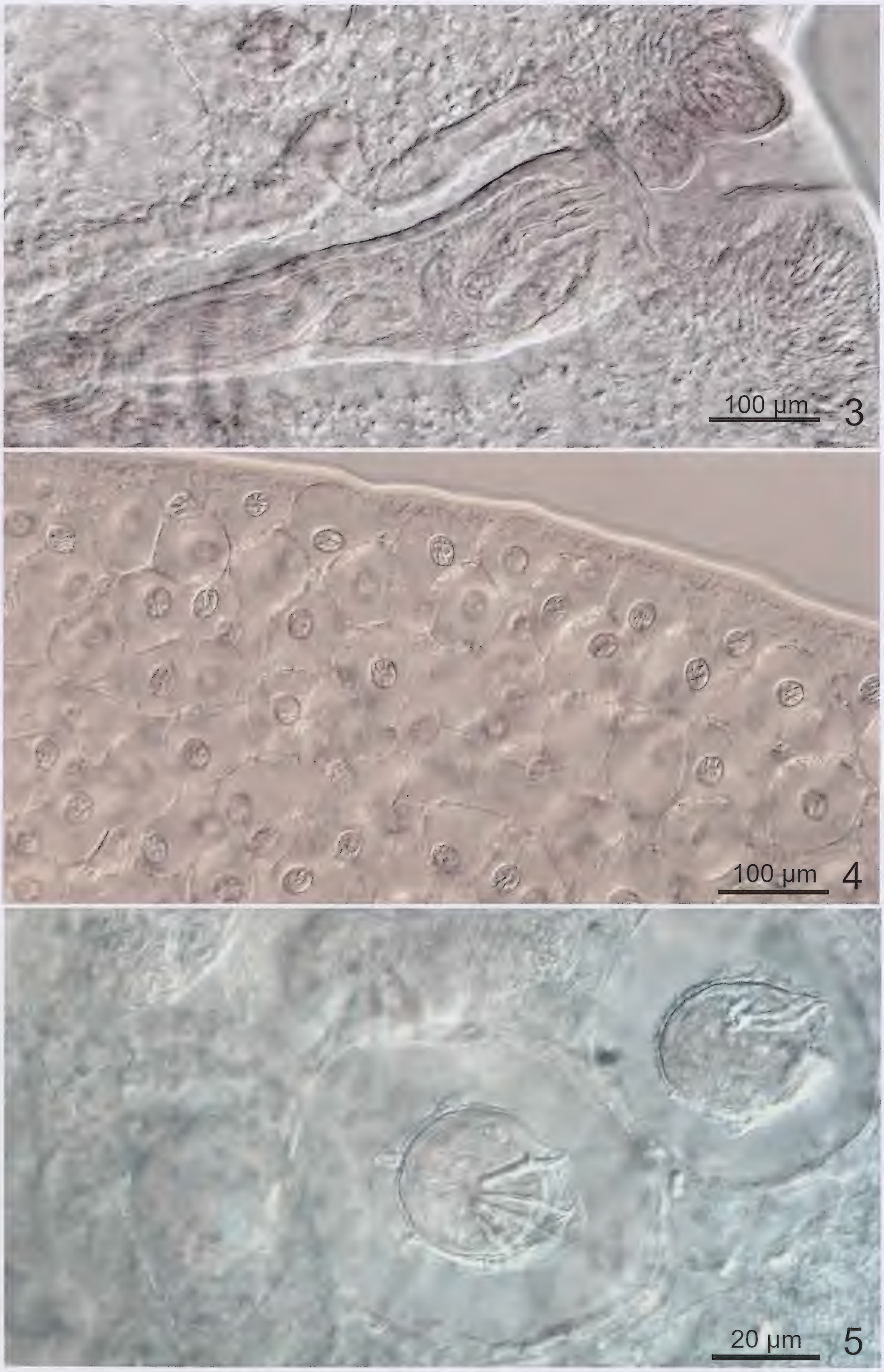

Fig. 3. *Oochoristica varanicola* sp. nov. Copulatory organs. Fig. 4. *Oochoristica varanicola* sp. nov. Eggs in gravid proglottis. Fig. 5. *Oochoristica varanicola* sp. nov. Eggs.

clearly differs from our material by its smaller scolex (160-230 µm), smaller suckers (110-140 µm), lower number of testes (20-50), and smaller number of ovarian lobules (4-6) (McAllister & Bursey, 2017).

Among the other taxa listed by McAllister & Bursey (2017) from Africa, none presents characters close to those observed in our material. The most similar species are *O. koubeki* Mašová, Tenora & Baruš, 2012, and *O. zonuri* Baylis, 1919 which possess a cirrus-sac of similar length but far fewer testes and different scolex dimensions. Our observations of the type material of *O. zonuri* also confirm that the testes extend to the anterior margin of the segment as shown in the original description (Baylis, 1919: fig. 2), which thus excludes this species from *Oochoristica sensu* Beveridge (1994).

Our material further differs from most other known species in various hosts and localities because of its rare combination of a long cirrus-sac and high number of testes. The only species showing similar values for both traits are *O. bivitellobata* Loewen, 1940, *O. gracewileyae* Loewen, 1940, *O. leonregagnonae* Arizmendi-Espinosa, Garcia-Prieto & Guillen-Hernandez, 2005 and *O. rostellata* Zschokke, 1905. *Oochoristica bivitellobata* was reported from a member of the Teiidae in Kansas, USA. It is a very short worm consisting of only a small number of proglottides, small scolex (396 µm) and suckers (140 µm) and although both its cirrus sac length and testis number ranges overlap that of our material, they remain shorter (165 µm) and fewer (76) on average. The testes are also distinctly posterior, not reaching the lateral sides of the female organs (Loewen, 1940). *Oochoristica gracewileyae* was found in a rattlesnake in Texas. It also possesses a smaller scolex and suckers (426 µm and 145 x 152 µm respectively). Its cirrus-sac has a distinctive globular proximal extremity and does not extend beyond the excretory canals, and its testes are entirely posterior to the female genital complex (Loewen, 1940). *Oochoristica leonregagnonae* was reported from an Iguanidae in Mexico. Although similar, its average number of testes (95) is lower, and its cirrus-sac length (180-230 µm) only marginally overlaps that of our material (Arizmendi-Espinosa *et al*., 2005). Finally, *O. rostellata* was found in a colubrid snake in Italy (Zschokke, 1905). In its original description, Zschokke (1905) mentioned "2 to 3 rows of testes… each with 16 to 20 testes", although his figure 3 shows 78 testes. Other metric data are lacking from this description and more recent reports (Baer, 1927; Della Santa, 1956; McAllister & Bursey, 2017) confuse various sources including data from *O. cryptobothrium* (von Linstow, 1906) that has been synonymized with it by some authors (Baer, 1927). Apparently Zschokke's species was subsequently found in North African snakes by Joyeux (1927), who described a much shorter cirrus-sac than that in our material. Our own observations of this material also confirm a lower number of testes 51-70 (60, n=5).

Oochoristica cryptobothrium was recognized as a valid species by Spasskii (1951) and McAllister & Bursey (2017) and its suggested synonymy with *O. rostellata* by Hughes (1940) or Della Santa (1956) have contributed to the great variation in the morphological features reported for this species. Von Linstow's (1906) original description, from a colubrid snake in Sri Lanka, is not sufficient to unambiguously characterize *O. cryptobothrium* and doubts remain about the validity of this taxon. Characteristics of this species, as summarized in McAllister & Bursey (2017) are based on a redescription of the original specimens provided by Fuhrmann (1927). We studied this material in the Geneva collections and note that although some of Fuhrmann's measurements are correct, major discrepancies, especially the length of the cirrus-sac (we measured 225 to 305 µm) and, to a lesser extent, the number of testes (about 50 to 60) exist. Our observations are approximate as the available material is not well preserved, but they nevertheless allow the separation of *O. cryptobothrium* from our material on the basis of a significantly lower number of testes. Additional specimens identified as *O. cryptobothrium* from a lizard from Accra (BMNH 1977.11.3.15-16) and re-examined appear to be *O. rostellata*. A detailed revision of all of the material currently attributed to *O. cryptobothrium* and *O. rostellata* is therefore needed.

In summary, our morphological observations, together with its geographical origin and host, allow us to conclude that our material from *Varanus albigularis* in Kenya represents a new species *Oochoristica varanicola* sp. nov.

Oochoristica varanicola is only the third (or possibly the second) species of the genus reported from monitor lizards, indicating that they are probably not ideal hosts for these anoplocephalids. Brooks *et al*. (1999) suggested that species of *Oochoristica* are highly specific and that their geographical distribution is restricted. Although our results seem to corroborate this assumption, it is difficult to confirm its generality given the limited availability of comparative material.

We should finally note that, for *Oochoristica,* like many groups of cestodes lacking rostellar hooks, specific identification relies heavily on a small number of strobilar characters. In the case of *Oochoristica*, some of them, *e.g.* testis numbers, are particularly difficult to observe and may often be inaccurate. As records for most species in the genus are scarce, independent verification of this character is problematic. Molecular data are essentially lacking in the group but will undoubtedly help clarify its structure and composition in the future.

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Revision of the genus *Hermonassa* Walker, 1865 (Lepidoptera, Noctuidae, Noctuinae). I. The *anthracina* and *dispila* species groups, with descriptions of four new species

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Abstract: Four new species of the genus *Hermonassa* from Pakistan (*H. moorei* sp. n., *H. tathabaya* sp. n. and *H. ayubia* sp. n.) and Nepal (*H. kalamantra* sp. n.) are described and compared with their relatives of the *H. anthracina* and *H. dispila* species groups. The specific status of *Hermonassa shizukoae* Sugi, 1995 is re-instated (stat. rev.). The species treatments are illustrated with 32 colour images and 24 genitalia figures.

Keywords: Noctuoidea - new status - Palearctic - Pakistan - Nepal.

INTRODUCTION

The genus *Hermonassa* Walker, 1865, is one of the giant Noctuinae clades. It is a strictly Palaearctic group, with all known species occurring in the Himalayan-Sino-Pacific subregion in the wide sense, including the northern parts of Indochina, Taiwan, and temperate Pacific Asian territories (Manchuria, Korea, Russian Far East, and Japan. The overwhelming majority of the species were described after the regular use of the genitalia studies. The first few species were described by the famous lepidopterists of the nineteenth and early twentieth centuries F. Walker (1865), F. Moore (1867, 1881, 1882, 1883), A.G. Butler (1878, 1881), J.H. Leech (1900), G.F. Hampson (1911) and W. Warren (1909-1913). The adoption of genitalia preparation techniques and the treatment of the vast material collected in the Himalayan region in the wide sense demonstrated the existence of numerous hidden species with often confusingly similar external appearances. Fundamental work in the exploration of the diversity of the genus was made by Boursin (1967, 1968a, b) and his work was followed by others (in alphabetic order): Chen (1985, 1989, 1991, 1992, 1993, 1999), Han & Li (2007), Hreblay & Plante (1995a, b, 1996), Hreblay & Ronkay (1997, 1998), Hreblay, Peregovits & Ronkay (1999), Owada (1985), Plante (1994) and Sugi (1995). As a result of their discoveries, the genus comprises more than 90 described species and we expect this number to increase markedly in forthcoming studies.

Despite great interest about the genus, only regional monographs and species descriptions have been published so far; no attempt toward a synthetic taxonomic revision has been made. However, the regional works available clearly show, the intense allopatric speciation within the main lineages, the surprising species richness in diversity hotspots in the Himalayan-Sino-Tibetan area, as well as the fragmentation of *Hermonassa* s.l. All these facts demand a thorough taxonomic revision of the genus.

The present paper contains the first results of this ongoing revision, including the descriptions of four new species in the closely related *H. anthracina* and *H. dispila* species groups.

ABBREVIATIONS

GYP	genitalia slide prepared by Péter Gyulai
HNHM	Hungarian Natural History Museum, Budapest
IC ENTO	specimen identity code of the entomological collections of the MHNG
KST	genitalia slide prepared by Sándor T. Kovács
MHNG	Muséum d'histoire naturelle, Geneva, Switzerland
MNHU	Museum für Naturkunde, Humboldt-Universität, Berlin, Germany
NHM UK	Natural History Museum (formerly British Museum, Natural History), London, United Kingdom
NHMW	Naturhistorisches Museum, Vienna, Austria
NIAES	National Institute of Agro-Environmental Sciences, Tsukuba, Japan (NARO)
PL	genitalia slide prepared by Jacques Plante

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RL genitalia slide prepared by László Ronkay
ZFMK Zoologisches Forschungsmuseum Alexander Koenig, Bonn (AKM)
ZSM Zoological Museum of the Bavarian State (Zoologische Staatssammlung), Munich, Germany

SYSTEMATIC PART

Genus *Hermonassa* Walker, 1865

Hermonassa Walker, 1865: 631, type species *Hermonassa consignata* Walker, 1865 by monotypy.

The *anthracina* group

The species group includes two allopatric species, the Sino-Tibetan *H. anthracina* Boursin, 1967 and the southern Himalayan *H. kalamantra* sp. n. The members of this species group are externally similar to the overwhelming majority of the taxa of the *H. dispila* Boursin, 1967 species group but are distinguished from them by their somewhat narrower and more elongated forewings (with somewhat larger wingspan, 27-33 mm vs 25-30 mm, respectively), and the darker, more blackish-grey suffused thorax and forewing ground colour.

The species group is characterised by certain features of the strongly autapomorphic copulatory organs of both sexes. The most conspicuous autapomorphy of the male clasping apparatus is the heavily sclerotised and laterally or proximo-laterally projecting, cristate-folded saccular lobe, fitting well in the hole between the last abdominal sternite and the postero-lateral lobe of the also heavily sclerotised antrum of the female abdomen. Other diagnostic features of the male genitalia are the relatively short and apically strongly dilated, spatulate uncus, the deltoidal juxta, the very long and ventrally broadly rounded, heavily sclerotised vinculum, the bilobate valva and the apically dilated and rounded clasper (= "harpe" in the former works dealing with the genus) (males), the rather bull-head-shaped and heavily sclerotised antrum and the strongly sclerotised quadrangular plates of the ductus bursae (females). The above-mentioned apomorphic features strictly distinguish the *anthracina* species group from the morphologically more heterogeneous *dispila* species group which have much less developed (or fully reduced) saccular extensions, longer and thinner claspers, much weaker vinculum and saccus and a differently shaped vesica with stronger subbasal cornutus in males, much weaker sclerotised, cup-shaped (calyciform) or lyriform antrum and the usually well-developed signa of the corpus bursae in the females.

Hermonassa anthracina Boursin, 1967

Plate 1 figs 1-4; genitalia Figs 1-2

Hermonassa anthracina Boursin, 1967: 26, pl. 1, fig. 4; gen. fig. pl. 3, fig. 4.

Type locality: China, Yunnan, Li-kiang, 3400 m.

Type material examined: Holotype, in coll. ZFMK, male, [China] "Li-kiang ca 4000 m | Prov. Nord-Yuennan | 27.7.1935. H. Höne" (yellow label); "Holotypus" (red label); Hermonassa anthracina Brsn. ♂| Holotype | Boursin det." (coll. ZFMK). – Paratypes, China, numerous specimens from the same area, 2000-4000 m altitudes, July-September 1935, IC ENTO 25445, 25446, 25473, 25474, slide Nos RL12614m, RL12616m (males), RL12615f, RL12617f (females) (coll. ZFMK and coll. Plante, MNHG).

Additional material examined: China, Yunnan. 1 male, W. Sichuan, road Yajiang-Litang, 3600 m, 29°59'N, 100°52'E, 15.VII.2009, leg. Floriani & Saldaitis, slide No. KST882m (coll. G. Ronkay, NHMW).

Diagnosis: The species is externally very similar to its allopatric twin species, *H. kalamantra*. Specific differences are found in details of the genitalia structures. In males, the main differences can be found in the shape and size of uncus, juxta, clasper, and saccular lobe; in females, in the shape and size of the antrum and the sclerotised plates of the ductus bursae. A detailed comparison of the two species is given in the diagnosis of *H. kalamantra*.

Distribution: Sino-Tibetan. The species is known from the SE frontier of the Tibetan plateau (Sichuan, Yunnan).

Remarks: The type series is mixed, the paratypes from Nepal and northern India representing in fact the southern Himalayan sister species *H. kalamantra* sp. n.

Hermonassa kalamantra sp. n.

Plate 1 figs 5-8; genitalia Figs 3-6

Holotype: Male, Nepal, Annapurna Himal, Mesokantu pass, 4200 m, 28°44'N, 83°47.5'E, 12-13.VII.1995, leg. G. Csorba, Gy.M. László & G. Ronkay, slide No. KST875m (coll. MHNG).

Paratypes

Nepal, West Nepal: 1 female, 21 km N of Dailekh, 3400 m, 1-2.VIII.1996, leg. M. Hreblay & B. Szin, IC ENTO 25507 (coll. MHNG).

Nepal, Annapurna Himal: 5 specimens, Nangethanti, 2500 m, 83°43'E, 28°23'N, 4.X.1994, leg. G. Csorba & L. Ronkay, slide No. KST996m (male) (coll. G. Ronkay, NHMW and HNHM). – 2 specimens, Bhaleodar, 2400 m, 8.X.1994, Csorba & Ronkay (coll. G. Ronkay, NHMW). – 1 male, 1 female, S of Poon Hill, Pulvani, 3050 m,

20.VI.2012 (coll. P. Gyulai). – 5 males, Noma pasture, 11 km SE Jomsom, 4000 m, 28°44.5'N, 83°48'E, 9-11. VII.1995 and 17-18.VII.1995, leg. G. Csorba, Gy. M. László & G. Ronkay. – 1 male, Mesokantu pass, 4200 m, 28°44'N, 83°47.5'E, 12-13.VII.1995, leg. G. Csorba, Gy. M. László & G. Ronkay (coll. G. Ronkay, NHMW).
Nepal, Ganesh Himal: 1 male, 1 female, Yurekharka, 3450 m, 16.IX.1995, Herczig & László, slide No. KST999f (female) (coll. HNHM). – 1 specimen, 7 km W Godlang, 2950 m, 20.IX.1995, Herczig & László (coll. HNHM). – 2 males, Godlang, 2520 m, 13.X.1995, leg. S.T. Kovács (coll. S.T. Kovács). – 6 males, Gholjong, 2420 m, 12.X.1995, leg. S.T. Kovács (coll. S.T. Kovács). – 2 males, 2 km W of Thangjet, 2300 m, 85°17'E, 28°10'N, 23.IX.1994, leg. M. Hreblay & T. Csővári, IC ENTO 25465, 25466. – 2 males, 1 km S of Somdang, 3180 m, 85°17'E, 28°10'N, 21.IX.1994, leg. M. Hreblay & T. Csővári, IC ENTO 25467, 25506. – 1 female, 1 km E of Somdang, 3850 m, 85°13'E, 28°10'N, 23.VII.1995, leg. M. Hreblay & T. Csővári, IC ENTO 25511. – 1 female, 1 km W of Somathang (= Somdang), 3180 m, 18.VI.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25496. – 2 males, 4 females, 3 km SE of Somdang, 3450 m, 85°13'E, 28°11'N, 25.VII.1995, leg. M. Hreblay & T. Csővári, IC ENTO 25509, 25510, 25512, 25513. – 1 male, 4 females, Somathang (= Somdang), 3270 m, 15.VI.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25462, 25497, 25498, 25500, 25502. – 2 females, 3 km NE of Sunpati, 2330 m, 13.VI.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25499, 25501. – 1 male, Khurpudanda Pass, 3650 m, 85°13'E, 28°11'N, 20.IX.1994, leg. M. Hreblay & T. Csővári, IC ENTO 25469 (coll. MHNG). – 3 males, Khurpudanda Pass, 3600 m, 85°13'E, 28°12'N, 22.VII.1995, leg. M. Hreblay & T. Csővári (coll. T. Csővári). – 8 males, 6 females, 1 km E of Yurekharka, 3200 m, 85°15'E, 28°10'N, 22.IX.1994, leg. M. Hreblay & T. Csővári, IC ENTO 25470, 25471, 25472, 25503, 25504, 25505 (coll. MHNG and T. Csővári). – 2 males, 3 females, Corikharkha, 3000 m, 16-17.IX.1995, leg. P. Gyulai & A. Garai (coll. P. Gyulai). – 1 female, Khalcapharka, 3400 m, 17-19.IX.1995, leg. P. Gyulai & A. Garai (coll. P. Gyulai). – 5 males, 4 females, Sanlaggothe, 3400 m, 21-22.IX.1995, leg. P. Gyulai & A. Garai (coll. P. Gyulai). – 3 males, 2 females, Gadlang, 2600 m, 22-23.IX.1995, leg. P. Gyulai & A. Garai, slide GYP4172m (coll. P. Gyulai). – 1 female, 1 km SE of Sondang, 3300 m, 20-21.IX.1995, leg. L. Németh (coll. P. Gyulai). – 2 specimens, Khurpudanda pass, NE slope, 85°12'E, 28°10,5'N, 3600-3700 m, 13-16.V.1995, leg. Gy. Fábián & L. Ronkay. – 22 specimens, 7 km W of Godlang, 2950 m, 28°10'N, 85°17'E, 14.IX.1995, leg. B. Herczig & Gy.M. László. – 6 specimens, Gothen village, 3150 m, 28°09'N, 85°12'E, 15.IX.1995, leg. B. Herczig & Gy.M. László. – 8 specimens, Yurekharka, 3450 m, 16.IX.1995, leg. B. Herczig & Gy.M. László. – 1 specimen, Khurpudanda pass, 3720 m, 85°12'E, 28°10.5'N, 17-18.IX.1995, leg. B. Herczig & Gy.M. László. – 2 specimens, above Khurpudanda pass, 3850 m, 19.IX.1995, leg. B. Herczig & Gy.M. László. – 7 specimens, 7 km W Godlang, 2950 m, 85°14'E, 28°10'N, 20.IX.1995, leg. B. Herczig & Gy.M. László. – 2 specimens, 1 km W of Somdang (Somathang), 3850 m, 16.VI.1993, leg. G. Csorba & M. Hreblay (coll. G. Ronkay, NHMW).
Nepal, Langtang: 2 specimens, 2 km S of Dhunche, 2110 m, 28°04'N, 85°14'E, 23.IX.1994, leg. G. Csorba & L. Ronkay (coll. G. Ronkay, NHMW and HNHM). – 57 specimens, Chandrabari, 2860 m, 85°21'E, 28°07'N, 25.IX.1994, leg. Csorba & Ronkay, slide Nos KST874m, KST878m, KST997m (males), KST876f, KST881f (females) (coll. G. Ronkay, NHMW and HNHM). – 7 specimens, 3500 m, between Cholang Pati and Dimsa, 85°22'E, 28°05'N, 26.IX.1994, leg. G. Csorba & L. Ronkay (coll. P. Gyulai, G. Ronkay and HNHM). – 31 specimens, 2850 m, 3 km SE Syabru, 85°21'E, 28°07'N, 27.IX.1994, leg. G. Csorba & L. Ronkay, slide Nos KST879m, KST998m (males), KST877f, KST880f (females) (coll. P. Gyulai, G. Ronkay and HNHM). – 1 specimen, 1.5 km NE Dhunche, 1950 m, 85°18'E, 28°06'N, 24.IX.1994, leg. Csorba & Ronkay (coll. G. Ronkay, NHMW).
Nepal, Solu Khumbu Himal: 26 specimens, Yak Kharka, 12 km E of Lukla, 4000 m, 28.VI.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25448, 25450, 25452, 25453, 25454, 25459, 25460, 25461, 25475, 25476, 25477, 25478, 25480, 25481, 25482, 25483, 25484, 25485, 25486, 25487, 25488, 25489, 25492, 25493, 25494, 25495. – 7 specimens, 7 km E of Lukla, 3450 m, 1.VII.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25449, 25451, 25455, 25456, 25458, 25463, 25490. – 1 female, 5 km E of Lukla, 3200 m, 27.VI.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25479. – 2 females, Lamjura Pass, 3500 m, 5.VII.1993, leg. M. Hreblay & G. Csorba, IC ENTO 25457, 25491 (coll. MHNG). – 3 specimens, 12 km E Lukla, Yak Kharka, 4000 m, 30.VI.1993, leg. M. Hreblay & G. Csorba. – 1 specimen, 7 km E of Lukla, 3450 m, 1.VII.1993, leg. M. Hreblay & G. Csorba (coll. G. Ronkay, NHMW).
Nepal, Kanchenjunga Himal: 1 male, 6 km S of Ghunsa, 4160 m, 23.VI.1998. – 1 male, Jyaudra danda, 1 km N of Khambachen, 4250 m, 1998.VI.28 (coll. HNHM). – 2 females, from the same locality, 15-16.VIII.2000, leg. M. Hreblay & T. Csővári (coll. P. Gyulai). – 1 male, 1 female, Deorali danda, 2 km SSW of Ghunsa, 4060 m, 14-15.VIII.2000, leg. M. Hreblay & T. Csővári (coll. P. Gyulai).
Nepal, Taplejung area: 1 male, Lal Kharka, 2250 m, 10.X.1994, leg. M. Hreblay & T. Csővári, IC ENTO 25464. – 1 male, 1 km NE Suketar, 2500 m, 9.X.1994, leg. M. Hreblay, IC ENTO 25468 (coll. MHNG).
China, Tibet: 4 females, Nyalam, 10-12.VII.2001, leg. Bieber (coll. P. Gyulai).

Additional material: The Nepalese specimens of the type series of *H. anthracina* designated by Boursin

(1967) from the collection of the ZSM (Khumbu, Khumdzung, 3900 m, June-July 1962, Ebert & Falkner leg., Thodung, 3100 m, 21-30 May and 1 June 1962, Ebert & Falkner leg., Prov. Nr. 3 East, Pangpoche, 4000 m, 4 July 1964, leg. Dierl, Khumjung, 3800 m, 14 July 1964, leg. Dierl, Junbesi, 2750 m, 25-31 July 1964, leg. Dierl, Dudh Kosi Tal, 3500 m, 22-23 July 1962, Ebert & Falkner leg.) and the two male specimens from NE India (Champetang, N.E. India, 12.000 ft., 15 Aug. 1927, F. M. Bailey leg., coll. NHMUK) belong most probably to this species. As none of these specimens has been dissected yet, they are not included into the type series.

Diagnosis: The two species are very similar externally, the new species is somewhat darker, more blackish-grey coloured, with finer black markings. The specific differences can be found in the genitalia of both sexes.
In the male genitalia, *H. kalamantra* has, in comparison with *H. antracina*, somewhat shorter and evenly widening uncus, broader, dorsally much stronger dilated juxta, distally more dilated, apically broadly flattened-discoidal clasper and proximally, almost rectangularly ventrally projecting sacculus. In *H. anthracina*, the uncus is longer and thinner, with only the apical third dilated, the lateral sides of the juxta are more or less parallel, the clasper is more elongated and almost evenly broad, with only slightly dilated and rounded apical section, and the sclerotised sacculus is much less projecting ventrad than in its sister species (genitalia Figs 1, 3 and 4).
In the female genitalia, the sclerotised antrum of *H. kalamantra* is broader and more robust than in *H. anthracina*, with larger antero-lateral lobes, narrower and deeper postero-medial cleft and longer, more laterally projecting sclerotised plates of apophyses anteriores, while the sclerotised plates of ductus bursae are considerably shorter in the Nepalese species than in its Chinese sister taxon (genitalia Figs 2, 5 and 6).

Etymology: The specific name refers to the dark colouration and the fine black(ish) markings of the moths.

Description

External morphology: Medium-sized species, wingspan 28-32 mm. Head and thorax unicolorous dark chocolate brown mixed with blackish grey hair-scales; palpi short, slightly upturned, laterally darkened; collar small and rounded, blackish, darker than other parts of thorax, without whitish dorsal edges; antennae of both sexes filiform with short fasciculate cilia, somewhat thinner in females; pubescence of legs dark grey. Forewings long, narrow, apically pointed; ground colour shining, dark chocolate brown suffused with fumous grey and sparsely irrorated by blackish and pale-grey scales. Antemedial and postmedial crosslines double, fine, blackish grey, former more or less straight, latter sinuous; median fascia diffuse or obsolete, dark brown grey. Orbicular stigma small, more or less rounded, black; reniform stigma a fine, long black arch; claviform stigma absent or a tiny dark, shadow-like spot. Subterminal line fine, partly interrupted, pale ochreous defined by dark grey-brown inner shadow; terminal line ochreous, followed by thin dark-brown streaks; fringes as ground colour, with slightly paler inner lines. Hindwing whitish or ochreous grey, irrorated by darker grey scales; veins covered by brown; discal spot pale, thin, greyish with pale inner crossvein; diffuse marginal area and inner margin suffused with greyish brown. Terminal line fine, whitish ochreous, followed by brownish inner stripe; fringes ochreous brown with darker brown inner line. Underside of forewing silky grey, patternless; underside of hindwing whitish grey with ochreous whitish sheen; discal spot greyish.
Male genitalia: Uncus medium long, sclerotised and flattened, evenly dilated towards broadly spatulate-triangular apex. Tegumen wide and short, penicular lobes minute, less hairy. Juxta reversed deltoidal, dorsally strongly dilated. Vinculum very long, heavily sclerotised, more or less V-shaped, with broadly rounded tip; sclerites connecting tegumen and vinculum strong, slightly S-shaped. Valva rather bilobate, relatively short and basally broad, costal lobe membranous, densely setose, with strong hair-pencils; corona absent. Saccular part heavily sclerotised, its distal half cristate and folded, more or less foot shaped and projecting ventrad and backwards almost rectangularly to basal segments of abdomen. Clasper large, heavily sclerotised, hockey-stick shaped, with slender basal half and strongly dilated, flattened, discoidal apical half. Aedeagus long, tubular, coecum penis broader and terminally curved dorsally; distal part of aedeagus tapering; carina with longer dorsal and shorter ventral eversible sclerotised bars. Vesica shortly tubular, with long, subconical subbasal diverticulum terminated in a minute cornutus; medial section bent ventral and recurved towards coecum penis, membranous with variably strongly scobinate walls, latero-medial diverticulum small, rather crest-like, membranous; distal third forms a semiglobular, large, membranous diverticulum; ductus ejaculatorius originates laterally from basal part of this terminal diverticulum.
Female genitalia: Ovipositor medium long, conical; papillae anales elongated, apically finely pointed and sparsely setose; apophyses posteriores short, fine, straight. Penultimate segment broad, sclerotised; basal plates of apophyses anteriores heavily sclerotised and folded; apophyses anteriores short, stick-like. Antrum large, heavily sclerotised, flattened, with smaller postero-medial and larger postero-lateral sclerotised lobes; postero-medial cleft U-shaped; anterior edge of sclerotised section evenly rounded, surrounded with hyaline margins. Ductus bursae medium long, as long as or slightly shorter than antrum; posterior section broad and flattened, with two heavily sclerotised, rather quadrangular plates with hyaline stripes between them;

anterior section tubular, membranous, slightly ribbed. Appendix bursae semiglobular-discoidal, strongly ribbed but not sclerotised; corpus bursae elliptical-sacculiform, strongly, densely ribbed; signum absent.

Bionomics and distribution: The new species inhabits the medium-high and high altitude forest belts and the subalpine regions of the southern Himalayas in Nepal and Sikkim. It appears locally frequent or even common. The species is supposedly univoltine with a partial summer diapause. The adults are on the wing from May to October, visiting the artificial light but are not attracted by sugar baits.

Remarks: The new species is the southern allopatric sister species of *H. anthracina*.
The differences between the male genitalia of the Nepalese species and the Chinese *H. anthracina* have been already noted by Sugi (1995) but without any taxonomic act.

The *dispila* group

The *dispila* species group is more heterogeneous than the related *anthracina* group, including a number of externally very similar species resembling certain taxa of the genus *Chersotis* Boisduval, 1840 with their relatively small size, short and rather broad forewings with characteristic colouration and forewing pattern, and a few differently looking taxa like, for instance, *H. spilota* Moore, 1867, *H. connudata* Chen, 1991, and *H. chryserythra* Boursin, 1968. The genitalia of these species show different trends of change in certain features which led to the often remarkable differences between the male genital capsule of the different lineages of the clade. Due to the basically uniform external appearance and the genital features of the entire species group, as well as partly overlapping differential characters, the taxa of the species group can be arranged into different lineages.
The *dispila* species group comprises the following species: *H. dispila* Boursin, 1967, *H. chersotidia* Boursin, 1968, *H. moorei* sp. n., *H. cyanolepis* Boursin, 1967, *H. renifera* Chen, 1991, *H. shizukoae* Sugi, 1995, *H. ayubia* sp. n., *H. tathabaya* sp. n., *H. spilota*, *H. connudata, H. chryserythra* and *H. oxyspila* Boursin, 1968.

Hermonassa moorei sp. n.

Plate 2 figs 1-4; genitalia Figs 7-8

Holotype: Male, Pakistan, Himalayas, Kaghan valley, 2200 m, Tathabaya, 23-24.VIII.1998, leg. G. Ronkay & Z. Varga; slide No. RL6701m (coll. Ronkay, NHMW).

Paratypes
Pakistan: 1 male, Himalayas, Kaghan valley, 2200 m, Tathabaya, 22.VIII.1998, leg. G. Ronkay & Z. Varga (coll. G. Ronkay, NHMW). – 1 female, Himalayas Kaghan valley, near Khanian village, 1770 m, 12-13.IX.1998 leg. P. Gyulai & A. Garai (coll. P. Gyulai). – 4 males, 4 females, Kaghan valley, above Shogran, Shiripaya, 3000 m, 18.VII. and 4.VIII.2011, slide Nos GYP4917m, GYP4921m (males), GYP4918f, GYP4920f, GYP4926f (females) (coll. P. Gyulai). – 1 female, Azad Jammu & Kashmir, near Thunian, 2300-2700 m, 25-30.VIII.2004, leg. V. Gurko, slide No. RL8570f (coll. G. Ronkay, NHMW). – [India or Pakistan] 1 male, Rala, H. McArthur coll., June 1888, Leech Coll. slide No. BMNoct 4693♂, "Holotype", "Hermonassa moorei Brsn." (manuscript name) (coll. NHM UK London).
India: 1 female, [Kashmir] Goorais valley, June 1887, J.H. Leech Coll, 6000', gen. prep. Tams 1960/65, "Paratype", "Herm. moorei Brsn." (manuscript name)(coll. NHM UK London). – 1 male, Jammu & Kashmir, Bal valley near Sonamarg, 1.VIII.1981, leg. W. Thomas, slide No. PL807, IC ENTO 24975 (coll. J. Plante, MHNG).

Diagnosis: The new species differs externally from the otherwise very similar and sympatrically occurring *H. tathabaya* and *H. ayubia* by its more densely brown suffused hindwings, the stronger double postmedial line with deeper angle inwards below the medial veins, and the somewhat broader reniform stigma, from *H. ayubia* also by the paler collar; from *H. renifera, H. shizukoae, H. cyanolepis, H. dispila, H. chersotidia* and *H. oxyspila* by its paler, only basally blackish collar, more pointed forewing, more oblique, medially not inwards angled antemedial line, better defined and more inwards angled postmedial line and, with the exception of *H. chersotidia*, also by its darker hindwings.
The male genitalia of *H. moorei* (genitalia Fig. 7) differ conspicuously from those of all known relatives by the short and broad valva with shortly triangular cucullus and vary large, sclerotised sacculus, the very strongly sclerotised, evenly tapering, rather horn-like long clasper, the arched tower-like sclerotised medial crest of juxta based on small, rounded basal plate and the very large, strongly bulbed cornutus of the vesica.
The diagnostic features of the female genitalia (genitalia Fig. 8) are the large, heavily sclerotised plates of the penultimate segment, the presence of a second, posteriorly arranged sclerotised plate at ostium bursae, the large, caudally projecting and cristate-ribbed appendix bursae and the single, short signum plate in fundus bursae.

Description
External morphology: Medium-sized species, wingspan 30-31 mm. Head and thorax dark chocolate brown; palpi short, slightly upturned, laterally darkened; collar small and rounded, pale brown with blackish basal stripe, generally paler than tegulae; antennae of both sexes filiform with short fasciculate cilia; pubescence of legs ochreous brown. Forewings elongated, narrow, with pointed apex; ground colour dark hazel brown to chocolate brown, sparsely irrorated by darker brown

and a few ochreous scales. Subbasal and antemedial lines double, rather straight, latter slightly oblique and angled outwards at anal vein. Postmedial crosslines double, rather indistinct, strongly sinuous laced, dark grey brown, angled strongly inwards below cell; median fascia obsolete or absent. Orbicular and reniform stigmata conspicuous, black(ish), orbicular stigma large, irregularly shaped, more or less quadrangular, reniform stigma broadly lunulate; claviform stigma absent. Subterminal line fine, rather indistinct, pale ochreous defined by dark grey-brown inner shadow; terminal line ochreous, followed by tiny dark dots at veins; fringes paler than ground colour, ochreous brown with darker inner line. Hindwing ochreous brown, strongly suffused by cupreous brown, except in anal area; veins not or only slightly darker; discal spot poorly visible, slightly darker than ground colour, with pale inner crossvein. Terminal line slightly darker than marginal area; fringes pale ochreous brown with darker brown inner line. Underside of forewing patternless greyish brown; underside of hindwing ochreous brown; discal spot diffuse, darker brown with greyish centre.

Male genitalia: Uncus medium long, slender, apically slightly flattened; tegumen narrow and relatively long, penicular lobes minute, less hairy; juxta with small basal plate and arched tower-like sclerotised medial crest; transtilla with large, partly sclerotised medial flaps; vinculum short, sclerotised, V-shaped. Valva broadly triangular, with broad, sclerotised saccular part and short, triangular apical section (cucullus); corona absent. Saccular part dorsally evenly rounded, clavus not differentiated; clasper large, heavily sclerotised, its erect part horn-like, evenly tapering towards apex, slightly arched subapically, its ventral surface finely ribbed crested and setose; basal plate long, stick-like, fused with postero-ventral edge of sacculus. Aedeagus medium long, rather thick, arched, coecum penis weaker sclerotised than medial and distal sections; distal part of aedeagus with strong and long dorsal and short ventral carinal plates. Vesica short, ample, more or less discoidal, with small subbasal diverticulum armed by huge, strongly bulbed, thorn-like cornutus.

Female genitalia: Ovipositor short, conical; papillae anales elongated, apically finely pointed and sparsely setose; apophyses posteriores very short. Penultimate segment broad, basal plates of apophyses anteriores heavily sclerotised, rounded quadrangular; apophyses anteriores very short. Antrum large, cup shaped, sclerotised and flattened, with smaller postero-medial sclerotised plate. Ductus bursae relatively short, membranous with fine scobination and with two stronger sclerotised plates with hyaline stripe between them; appendix bursae large, elongated, projecting caudally, strongly ribbed cristate; corpus bursae elliptical-sacculiform, fundus bursae scobinate, with one single, short signum close to bottom of corpus bursae.

Bionomics and distribution: The species inhabits the medium-high altitude mixed woodlands of the south-western Himalayas in the Kaghan valley and Kashmir. A univoltine spring species whose known specimens have been collected between June and the end of August.

Etymology: The new species is dedicated to the great British lepidopterist, Frederic Moore, author of fundamental papers on the Noctuoid fauna of the Himalayan region.

Remarks: The species is closely related to *H. renifera*, *H. shizukoae* and *H. cyanolepis*, representing their allopatric western sister taxon. The new species was first recognised by Boursin who found two specimens in the material of the British Museum (now NHM UK) and named it as "*Hermonassa moorei*." This species has remained undescribed until its re-discovery in Pakistan and the Indian Kashmir. We accepted the dedication of Boursin and preserved the name "*moorei*" but the holotype was chosen from the newly collected specimens.

Hermonassa tathabaya sp. n.

Plate 2 figs 5-7; genitalia Figs 9-10

Holotype: Male, Pakistan, Himalayas, Kaghan valley, Tathabaya, 2200 m, 9-10.IX.1997, leg. Gy. Fábián & G. Ronkay, slide No. RL6751m (coll. Ronkay, NHMW).

Paratypes

Pakistan: 1 male, with the same data as the holotype (coll. G. Ronkay, NHMW). – 1 male, Kashmir, Himalaya Mts, Murree Hills, Ayubia, 2650 m, 73°24'E, 34°02'N, 31.VIII.-1.IX.2001, leg. G. Ronkay (coll. MHNG); slide Nos KST860m, KST861m (males). – 1 male, Himalaya Mts, Kaghan valley, Tathabaya, 2330 m, 73°26'E, 34°36'N; 11-12.IV.1998, leg. P. Gyulai & A. Garai, slide No. GYP4923m (coll. Gyulai).

Diagnosis: *Hermonassa tathabaya* differs from its externally most similar relative, *H. ayubia*, by its paler collar (a shared feature with *H. moorei*, all other similarly coloured species of the *dispila* group have prominently black or blackish-brown collars) and the somewhat thicker (not finely lunulate) black reniform stigmata. *Hermonassa tathabaya* can be distinguished from the other members of the *dispila* group, besides the paler collar, by the darker hindwings (except *H. chersotidia*) and the shape of the antemedial crossline, which obliquely turns outwards including its medial section in *H. tathabaya*, whereas this part of the antemedial line is directed obliquely to the base of the wing in the related taxa.

In male genitalia, *H. tathabaya* and *H. ayubia* differ from all other members of the species group by the configuration of the vesica. These two species have evenly curved, basally dilated tubular vesica with reduced subbasal diverticulum, the small and double-peaked (or

even multi-peaked) subbasal cornutus originates from the wall of the main tube. The clasping apparatus of the two species are conspicuously different (see the genitalia Figs 9-12), the specific features of *H. tathabaya* are the short and evenly thick basal 3/4 part and short but rather wide spatulate apex of uncus, the long and strong, apically pointed medial process of juxta, the rabbit-ear-shaped distal part of valva, the absence of the ventral saccular extension and the multi-peaked, rather mace-like cornutus of the vesica.

Description

External morphology: Medium-sized species, wingspan 31-33 mm. Head and thorax dark chocolate brown except paler ochreous-brown- to hazel-brown-coloured collar having blackish basal stripe; antennae filiform with short fasciculate cilia; pubescence of legs ochreous brown to dark brown. Forewings elongated, narrow, with finely pointed apex; ground colour dark chocolate brown, sparsely irrorated by minute dark scales. Subbasal and antemedial crosslines double, former straight, latter obliquely angled outwards at anal vein. Postmedial crossline double, outer line rather indistinct, inner line strongly sinuous laced, dark grey brown; median fascia hardly visible. Orbicular and reniform stigmata conspicuous, black(ish), orbicular stigma large, more or less rounded, reniform stigma broadly lunulate; claviform stigma absent. Subterminal line indistinct, defined by shadow-like, interrupted, dark grey brown line; terminal line ochreous, followed by diffuse, tiny dark dots at veins; fringes as ground colour. Hindwing ochreous brown, strongly suffused by cupreous brown, except in anal area; veins not or only slightly darker than ground colour; discal spot diffuse, slightly darker than ground colour, with pale inner crossvein. Terminal line fine, ochreous; fringes brown. Underside of forewing patternless greyish brown; underside of hindwing ochreous brown; discal spot diffuse, darker brown with greyish centre.

Male genitalia: Uncus medium long, evenly slender, except its flattened, spatulate apex; tegumen relatively short, juxta with discoidal (rounded) basal plate and long, spine-like, acute medial process; transtilla with large, medial flaps covered densely with minute teeth; vinculum long and strong, V-shaped. Valva elongated, slender, saccular part sclerotised, clavus not differentiated; distal part membranous, rabbit-ear shaped, with finely pointed apex and strong hair-pencils; corona absent. Clasper long, slender, evenly broad, finely arched, with rounded apex, its basal plate long, stick-like, fused with postero-ventral edge of sacculus. Aedeagus medium-long, rather thick, finely arched; distal part of aedeagus with strong and long dorsal and long, strongly dentate, eversible ventral carinal plate. Vesica broadly tubular, bent ventrad, with broad dorso-lateral scobinate field; subbasal cornutus rather plate- or mace-like, with a number of tiny peaks.

Female: Unknown.

Bionomics and distribution: The new species is known from the medium-high and upper forest belts of the lower region of the Kaghan Valley and the Murree Hills. The specimens of the type series were collected at light between the end of August and the beginning of September, but are rather worn, the flight period most probably starts in midsummer.

Etymology: The new species is named after its type locality, a medium-high mixed woodland area in the Kaghan Valley.

Remarks: The two other, partly sympatrically occurring Pakistani species of the *dispila* species group, belong to two separate lineages due to their genitalia features. The male genitalia of the two externally rather similar new species show striking differences in practically all details; the female genitalia of the two species cannot be compared because the female of *H. tathabaya* is unknown.

Hermonassa ayubia sp. n.

Plate 2 fig. 8; Plate 3 figs 1-4; genitalia Figs 11-14

Holotype: Male, Pakistan, Kashmir, Himalaya Mts, Murree Hills, Ayubia, 2650 m, 73°24'E, 34°02'N, 10.VII.2000, leg. G. Ronkay & Z. Varga, slide No. KST863m (coll. G. Ronkay, NHMW).

Paratypes

Pakistan: 7 males, 1 female, with the same data as the holotype, slide Nos KST862m, KST865m, KST866m, KST867m, KST868m, KST870m, KST871m (males), KST864f (female). – 1 male, from the same site, 25-26.VIII.1998, leg. G. Ronkay & Z. Varga, slide No. RL6750m. – 5 males, 1 female, from the same site, 25-26.VII.2000, leg. G. Ronkay & Z. Varga, slide Nos KST872m, KST873m, KST883m, KST884m, KST885m (males), KST869f (female). – 2 males, 1 female, from the same locality, 10.VIII.2001, leg. G. Ronkay. – 2 males, 1 female, from the same locality, 31.VIII.-1.IX.2001, leg. G. Ronkay, slide Nos RL7561m (male), KST886f (female). – 3 females, Ayubia village, 2600 m, 18.VII.2011, slide No. GYP5053f. – 1 male, Ayubia NP, 28 km N of Murree, 2450 m, 2.VIII.1998, leg. T. Csővári & L. Mikus (coll. T. Csővári, P. Gyulai, S.T. Kovács, MHNG, G. Ronkay, NHMW, and Z. Varga).

Diagnosis: *Hermonassa ayubia* can be distinguished from its closest relative, *H. tathabaya*, by its dark collar and the thinner, finely lunulate black reniform stigma, and practically all details of the clasping apparatus of the male genitalia. It differs from the other members of the *dispila* group (except *H. chersotidia*) by its darker hindwings and the not inwardly angled medial section of antemedial line.

The male clasping apparatus of *H. ayubia* has, comparing with that of *H. tathabaya* (see the genitalia Figs 9-12),

longer and thinner, apically more dilated, more spatulate uncus, much larger basal plate of juxta with short, rather quadrangular medial process, thinner vinculum, well-developed ventral saccular extension and conical-pyramidal, often acutely-pointed cornutus in the vesica.

Description

External morphology: Medium-sized species, wingspan 31-33 mm. Head and thorax dark chocolate-brown; collar darker, blackish or blackish-brown; antennae of both sexes filiform, those of males with somewhat longer fasciculate cilia; pubescence of legs ochreous-brown to dark brown. Forewings elongated, narrow, with finely pointed apex; ground colour dark chocolate-brown; subbasal and antemedial lines double, former straight, latter obliquely angled outwards; postmedial crossline double, strongly sinuous-laced, dark grey-brown; median fascia hardly visible. Orbicular and reniform stigmata conspicuous, black(ish), orbicular stigma large, subtriangular, reniform stigma thin, lunulate; claviform stigma absent. Subterminal line indistinct, appearing often as an obsolescent row of tiny ochreous dots, followed by shadow-like darker line; terminal line ochreous, followed by diffuse, tiny dark dots at veins; fringes as ground colour. Hindwing ochreous-brown, strongly suffused by cupreous brown; veins not or only slightly darker than ground colour; discal spot diffuse, slightly darker than ground colour, with pale inner crossvein. Terminal line fine, ochreous; fringes brown. Underside of forewing patternless greyish-brown; underside of hindwing ochreous-brown; discal spot diffuse, darker brown with greyish centre.

Male genitalia: Uncus relatively long, slender, apically broadly spatulate; tegumen relatively short, juxta with large, rounded basal plate and small, more or less quadrangular medial process; transtilla with large, medial flaps covered densely with minute teeth; vinculum long and strong, V-shaped. Valva slender, with sclerotised saccular part, postero-ventral part of sacculus with strong, digitifrom saccular extension; clavus not differentiated; distal part membranous, rabbit-ear-shaped, with finely pointed apex and strong hair-pencils; corona absent. Clasper long, slender, evenly broad, finely arched, with rounded apex, its basal plate long, stick-like, fused with postero-ventral edge of sacculus. Aedeagus medium-long, rather thick, finely arched; distal part of aedeagus with strong and long dorsal and long, strongly dentate, eversible ventral carinal plate. Vesica broadly tubular, bent ventrad, dorso-lateral scobinate field broad, strong; subbasal cornutus pyramidal-conical or mace-like, usually with one or two peaks only.

Female genitalia: Ovipositor short, conical; papillae anales elongated, apically finely pointed and sparsely setose; apophyses posteriores very short. Penultimate segment broad, basal plates of apophyses anteriores sclerotised, narrow, elongated-saccate; apophyses anteriores very short. Antrum large, cup-shaped, sclerotised and flattened; ductus bursae medium-long, with funnel-like, partly sclerotised posterior and membranous-scobinate tubular anterior sections; appendix bursae subconical, projecting postero-laterally, its walls strongly ribbed; corpus bursae large, elliptical-sacculiform, fundus bursae scobinate, with two short signum-stripes.

Bionomics and distribution: *Hermonassa ayubia* is known from its type locality only. Its habitats are medium-high mixed coniferous forest areas of the Murree Hills. The freshly emerged specimens of the type series were collected at light in July, the flight period extends until the first half of September.

Etymology: The new species is named after its type locality, a famous resort in the Murree Hills in Pakistan.

Remarks: *Hermonassa ayubia* is a sympatric sister species of *H. tathabaya*.

Hermonassa dispila Boursin, 1967

Plate 4 figs 5-6; genitalia Figs 21-22

Hermonassa dispila Boursin, 1967: 30, pl. 2, fig. 16; gen. fig. pl. 6, fig. 11.

Type locality: China, Yunnan, Li-kiang, 4000 m.

Type material examined: Holotype, male, in coll. ZFMK, [China] "Li-kiang, ca. 4000 m | Prov. Nord-Yuennan | 22.8.1935. H. Höne" (yellow label); "Holotypus" (red label); "*Hermonassa dispila* Brsn. ♂ Holotype det. Boursin (white label) (coll. ZFMK). – Paratypes, China, 3 males, from the same locality, 3.IX., 8.IX., 10.IX.1935, IC ENTO 24747, 24748, 24750, slide Nos RL12588m, RL12589m (males) (coll. Plante, MHNG). – Paratypes, 3 males, Likiang, ca. 2000 m, 8.IX., 13.IX. and 14.IX.1935, IC ENTO 24749, 24751, 24752 (coll. Plante, MHNG).

Diagnosis: *Hermonassa dispila* differs externally from *H. chersotidia* mostly by its paler hindwing; the forewing crosslines are paler (or even obsolete) than in most specimens of its Nepalese sister taxon.

In the male genitalia, *H. dispila* has, comparing with *H. chersotidia* (see the genitalia Figs 19, 21 and 22), thinner and longer, a distally somewhat dilated and apically finely spatulate uncus, weaker basal plate of juxta with large triangular medial process, thinner basal section of clasper, and much shorter, finely-curved subbasal cornutus of vesica having a broader basal bulb.

Remarks: *Hermonassa dispila* is an allopatric sister-species of *H. chersotidia*.

Hermonassa chersotidia Boursin, 1968

Plate 4 figs 3-4; genitalia Figs 19-20

Hermonassa chersotidia Boursin, 1968b: 147, pl. 1 figs 18-20, gen. fig. pl. 5 fig. 41.

Type locality: Nepal, Thodung, 3100 m.

Type material examined: Holotype, in coll. ZSM, male, "Nepal, Thodung 3100 m| 1.VI.1962 | leg. G. Ebert u. H. Falkner | Staatsslg. München","Préparation No. MM 1057 Ch. Boursin" (white label with red letters), "ZSM Genitalprp. No. N1157♂", "Holotypus ♂ | *H. chersotidia* Brsn." (red label), "*Hermonassa chersotidia* Brsn. ♂ | Boursin det.","Abgebildet Brsn 1968 | Khumbu Himal, | 3(1) t. I., 18. (♂)" (coll. ZSM). – Paratype, coll. MNHU Berlin, male (paralectotype of *H. lunata* Moore), "Darjeeling| coll. Atkinson." "*Hermonassa lunata* ♂ Moore (type)", "Origin." (pink label), "coll. Staudinger | K. 342." "Préparation No. MB 456 Ch. Boursin" (white label with red letters), "Paratypus" (red label), "*Hermonassa chersotidia* Brsn. ♂ | Boursin det."

Additional material examined: A large series of some 150 specimens of both sexes from various regions of the Nepalese Himalayas, coll. HNHM, MHNG, ZSM, T. Csővári, Gy. Fábián, S.T. Kovács, and G. Ronkay, NHMW.

Diagnosis: *Hermonassa chersotidia* can be distinguished externally from *H. dispila* by its darker, more uniformly-brown suffused hindwings and the (in most specimens) more prominent, sometimes even sharply-defined antemedial and postmedial crosslines.
The male genitalia of *H. chersotidia* (genitalia Fig. 19) differ from those of *H. dispila* (genitalia Figs 21, 22) by the shorter and thicker, apically more pointed uncus, stronger sclerotised juxta without medial process, more robust clasper with wider basal section, and the much longer, straight, spine-like subbasal cornutus of vesica having smaller basal bulb.

Remarks: *Hermonassa chersotidia* represents the southern Himalayan twin species of *H. dispila*.

Hermonassa oxyspila Boursin, 1968
Plate 4 figs 7-8; genitalia Figs 23-24

Hermonassa oxyspila Boursin, 1968b: 144, pl. 1, fig. 15; gen. fig. pl. 4, fig. 39.

Type locality: Nepal, Prov. Nr. 3 East, Junbesi, 2750 m.

Type material examined: Holotype, in coll. ZSM, male, "Nepal, Prov. Nr. 3 East Junbesi 2750 m| 25–31 VII.1964 | leg. W. Dierl | Staatsslg. München," "Holotypus ♂ | H. oxyspila Brsn. | Zool. Staatsslg. München" (red label), "Hermonassa oxyspila Brsn. ♂ | Boursin det.," "Abgebildet Brsn 1968| Khumbu Himal, | 3(1) t. I., 15." (coll. ZSM).

Additional material examined: A large series of some 350 specimens of both sexes from various regions of the Nepal Himalayas, coll. HNHM, MHNG, ZSM, T. Csővári, Gy. Fábián, S.T. Kovács, and G. Ronkay, NHMW.

Diagnosis: *Hermonassa oxyspila* can be distinguished externally from *H. cyanolepis* by its much sparse irroration with bluish scales; from *H. shizukoae*, *H. renifera* and *H. dispila* by its stronger defined crosslines; from *H. chersotidia* by its paler hindwing and weaker noctuid pattern; from *H. tathabaya* and *H. ayubia* by its smaller size and paler hindwing.
The male genitalia of *H. oxyspila* (genitalia Fig. 23) are characterised by the long and straight uncus, rather cordiform basal plate of juxta with medium-long and thin, spine-like medial process, long and slender valvae with prominent but short, triangular ventro-medial saccular process, long and slender clasper, short and thick aedeagus with sclerotised dorsal and ventral eversible carinal bars, and the very long, tubular subbasal diverticulum of the vesica terminated in small, spiniform, basally bulbed cornutus. *Hermonassa oxyspila* differs from *H. shizukoae*, *H. renifera* and *H. cyanolepis* by its longer valvae, thinner clasper, longer and slenderer medial process of juxta and smaller cornutus of the vesica.
The female genitalia of *H. oxyspila* (genitalia Fig. 24) are easily separable from those of the members of the species group by the weaker sclerotised, lyriform antrum and the weakest sclerotised ductus bursae.

Remarks: *Hermonassa oxyspila* is considered here as the closest relative of the lineage comprising *H. shizukoae*, *H. renifera* and *H. cyanolepis* though the male genitalia show conspicuous similarity also with those of two externally rather dissimilar species, *H. spilota* and *H. connudata*.

Hermonassa cyanolepis Boursin, 1967
Plate 4, figs 1, 2; genitalia Figs 17-18

Hermonassa cyanolepis Boursin, 1967: 35, pl. 2, figs 30-31; gen. fig. pl. 9, fig. 25.

Type locality: China, Yunnan, Li-kiang, 2000 m.

Type material examined: Holotype, in coll. ZFMK, male, [China] "Li-kiang, ca. 2000 m | Prov. Nord-Yuennan | 1.7.1934. H. Höne" (yellow label); "Holotypus" (red label); "*Hermonassa cyanolepis* Brsn. ♂ Holotype det. Boursin" (white label) (coll. ZFMK). – Paratype, China. 1 male, from the same locality, 10.VI.1934, IC ENTO 24787 (coll. Plante, MHNG). – Paratypes, 1 male, 1 female, Likiang, ca. 3000 m, 19.IX. and 20.IX.1935, IC ENTO 24786, 24788, slide Nos RL12593m (male), RL12594f (female) (coll. Plante, MHNG).

Diagnosis: *Hermonassa cyanolepis* differs externally from all uniformly brown-coloured members of the species group by its prominent irroration of fine bluish scales.
The specific features of the male genitalia (genitalia

Fig. 17) are the broad valvae, the relatively less broad basal section of the clasper and the very long, spiniform cornutus of the vesica; the medial process of juxta is shorter and wider triangular than in *H. renifera* and *H. shizukoae*. The female genitalia of *H. cyanolepis* (genitalia Fig. 18) differ from those of *H. shizukoae* (genitalia Fig. 16) by the smaller antrum, longer ductus bursae and the much more strongly developed and long signum-stripes of the corpus bursae.

Remarks: *Hermonassa cyanolepis* is a member of the lineage comprising *H. shizukoae*, *H. renifera* and *H. cyanolepis*; it is also related to the *H. oxyspila* lineage.

Hermonassa renifera Chen, 1991

Hermonassa renifera Chen, 1991: 353, fig. 2.

Type locality: China, Prov. Xizang, Cona.

Holotype: In coll. IZAS Beijing, male, not examined.

Diagnosis: The study of authentic specimens of the species is still a target of future investigations. The similarity of the male genitalia of *H. renifera* shown by the drawing of Chen (1991, 1999) and the examined material of *H. shizukoae* inspired Hreblay & Ronkay (1998) to consider the two taxa as conspecific. Subsequent, intense investigations on the species group suggest to evaluate the smaller differences between the two taxa (shape and length of cucullus, shape of the enlarged basal part of clasper, and, especially, the length of the cornutus of the vesica) as specific ones.

Remarks: *Hermonassa renifera* is considered here as the northern, allopatric twin species of *H. shizukoae*.
The black and white illustration of the species (Chen, 1999: plate XI fig. 38) and the illustrations of the male genitalia published twice (Chen, 1991: fig. 2; 1999: fig. 171). It is unknown whether the published genitalia drawing refers to the holotype or the only known male paratype.

Hermonassa shizukoae Sugi, 1995 stat. rev.

Plate 3 figs 5-8; genitalia Figs 15-16

Hermonassa shizukoae Sugi, 1995: 92, pl. 117, figs 17, 18, genitalia figs 704, 730.

Type locality: India, West Bengal, 50 km NW of Darjeeling, 3600 m.

Type material examined: Holotype, in coll. NSMT, male, " India, W. Bengal, Sandakphu, ca 50 km NW of Darjeeling, 3600 m, 14.VIII.1985", "Genitalia slide No. SS-5155♂", "Shigero Sugi Collection", "HOLOTYPE" (red label), *Hermonassa shizukoae* Sugi ♂, det. S. Sugi, 1995" (coll. NIAES).

Additional material examined: A long series of about 130 specimens of both sexes from various parts of the Nepalese Himalayas.

Diagnosis: The species is characteristically concolorous brown, without or only pale or obsolete postmedial and subterminal lines. It resembles mostly *H. dispila* from which it is separable only by genitalia structures. The other members of the species group have either stronger postmedial (and subterminal) crossline(s), or darker hindwings, or (in case of *H. cyanolepis*) the forewing is irrorated with minute bluish scales.
The male genitalia of *H. shizukoae* (genitalia Fig. 15) are very similar to those of *H. renifera* (Chen, 1991: fig. 2; Chen, 1999: fig. 171), the most prominent difference between the two species can be found in the shape and size of the subbasal cornutus of the vesica, which is considerably longer and finer in *H. shizukoae* having smaller and narrower basal bulb. In addition, the distal part of the valva is more elongated in *H. shizukoae*, the basal part of clasper is less rounded and the distal section of clasper is proportionally shorter than in *H. renifera*.
The female genitalia of *H. shizukoae* (genitalia Fig. 16) has, in comparison with *H. chersotidia*, *H. cyanolepis* and *H. oxyspila*, broader and more regularly calyculate antrum and shorter ductus bursae; the signa are shorter and weaker than in the related species.

Remarks: The species belongs to the *H. cyanolepis* lineage, representing the southern Himalayan member of the species complex. It is considered here as distinct from *H. renifera* due to differences found in the male genitalia of the two taxa.

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Plate 1

1. *Hermonassa anthracina* Boursin, 1967 Holotype male, China, Yunnan

2. *Hermonassa anthracina* Boursin, 1967 male, China, Yunnan

3. *Hermonassa anthracina* Boursin, 1967 male, China, Yunnan

4. *Hermonassa anthracina* Boursin, 1967 male, China, Yunnan

5. *Hermonassa kalamantra* sp. n. Holotype male, Nepal

6. *Hermonassa kalamantra* sp. n. Paratype male, Nepal

7. *Hermonassa kalamantra* sp. n. Paratype female, Nepal

8. *Hermonassa kalamantra* sp. n. Paratype female, Nepal

Plate 2

1. *Hermonassa moorei* sp. n. Holotype male, Pakistan

2. *Hermonassa moorei* sp. n. Paratype male, Kashmir

3. *Hermonassa moorei* sp. n. Paratype female, Pakistan

4. *Hermonassa moorei* sp. n. Paratype female, Kashmir

5. *Hermonassa tathabaya* sp. n. Holotype male, Pakistan

6. *Hermonassa tathabaya* sp. n. Paratype male, Pakistan

7. *Hermonassa tathabaya* sp. n. Paratype male, Pakistan

8. *Hermonassa ayubia* sp. n. Paratype male, Pakistan

Plate 3

1. *Hermonassa ayubia* sp. n. Holotype male, Pakistan

2. *Hermonassa ayubia* sp. n. Paratype male, Pakistan

3. *Hermonassa ayubia* sp. n. Paratype female, Pakistan

4. *Hermonassa ayubia* sp. n. Paratype female, Pakistan

5. *Hermonassa shizukoae* Sugi, 1995 male, Nepal

6. *Hermonassa shizukoae* Sugi, 1995 male, Nepal

7. *Hermonassa shizukoae* Sugi, 1995 female, Nepal

8. *Hermonassa shizukoae* Sugi, 1995 female, Nepal

Plate 4

1. *Hermonassa cyanolepis* Boursin, 1967 Holotype male, China, Yunnan

2. *Hermonassa cyanolepis* Boursin, 1967 Paratype female, China, Yunnan

3. *Hermonassa chersotidia* Boursin, 1968 Holotype male, Nepal

4. *Hermonassa chersotidia* Boursin, 1968 female, Nepal

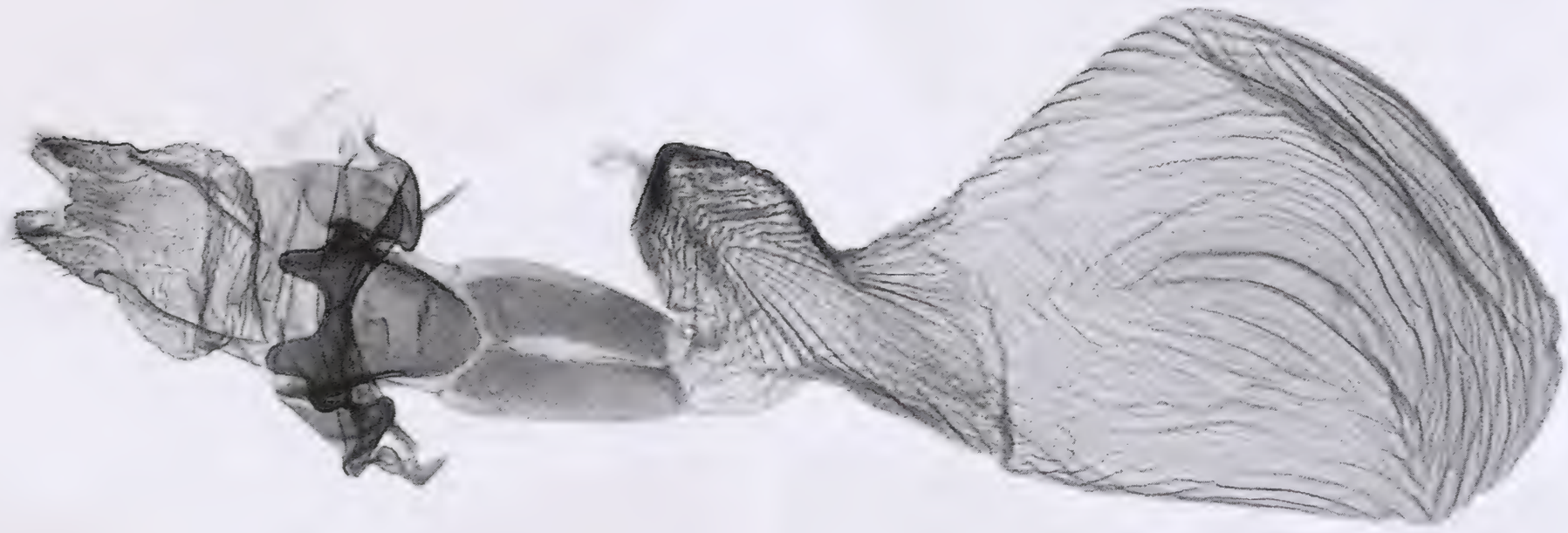
5. *Hermonassa dispila* Boursin, 1967 Holotype male, China, Yunnan

6. *Hermonassa dispila* Boursin, 1967 Paratype female, China, Yunnan

7. *Hermonassa oxyspila* Boursin, 1968 Holotype male, Nepal

8. *Hermonassa oxyspila* Boursin, 1968 female, Nepal

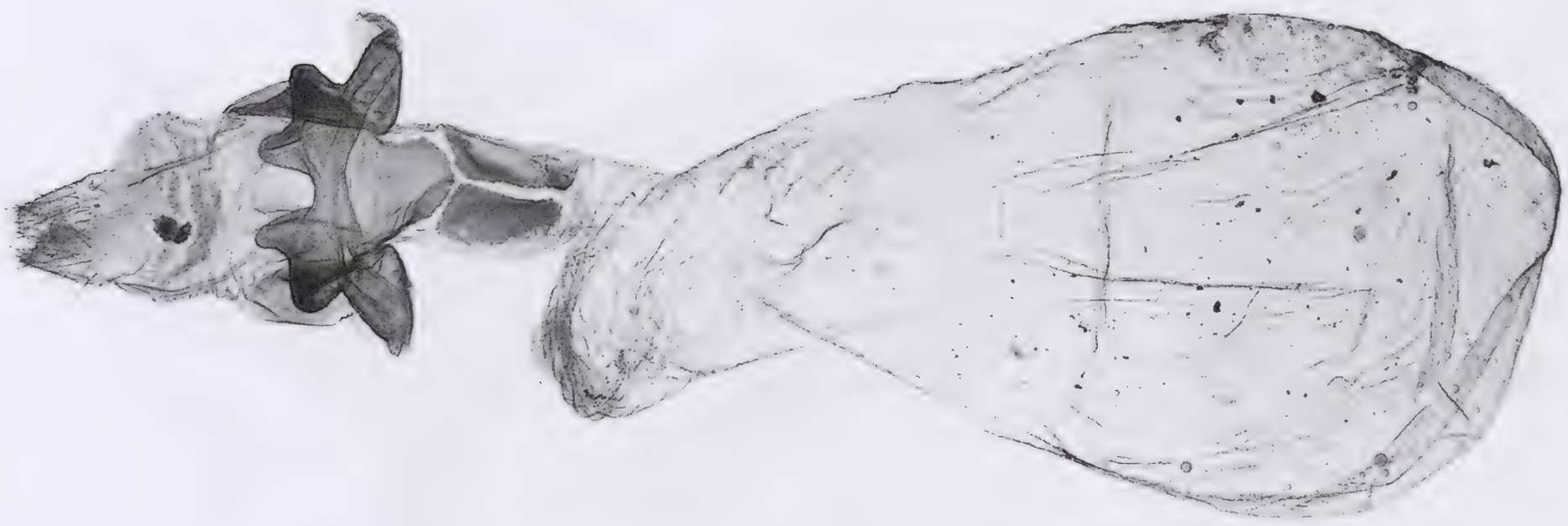
Gen. Fig. 1. *Hermonassa anthracina* Boursin, 1967 male KST882



Gen. Fig. 2. *Hermonassa anthracina* Boursin, 1967 female

Gen. Fig. 3. *Hermonassa kalamantra* sp. n. male Paratype KST874

Gen. Fig. 4. *Hermonassa kalamantra* sp. n. male Paratype KST878



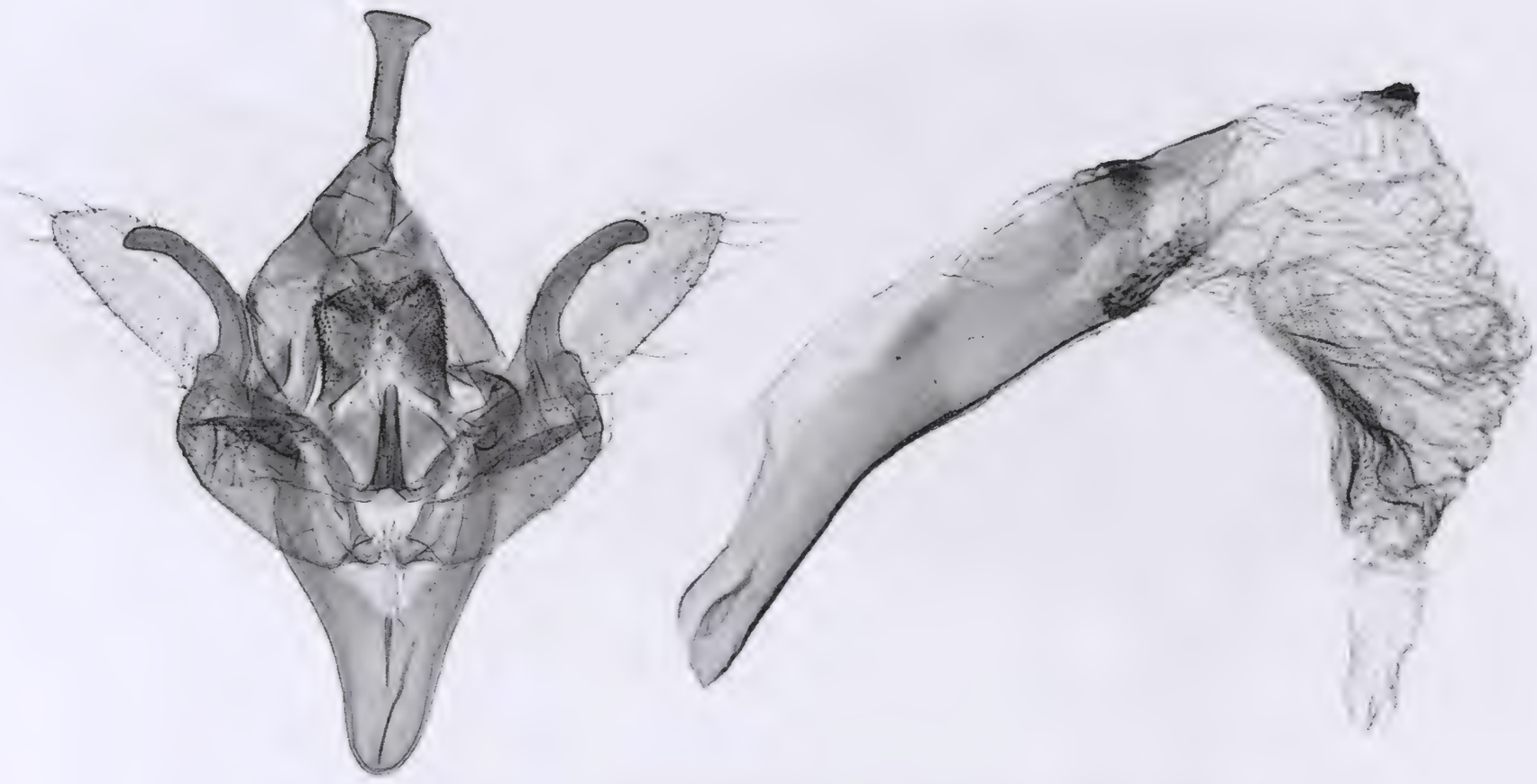
Gen. Fig. 5 *Hermonassa kalamantra* sp. n. female Paratype KST880

Gen. Fig. 6. *Hermonassa kalamantra* sp. n. female Paratype KST881

Gen. Fig. 7. *Hermonassa moorei* sp. n. male Holotype RL6701

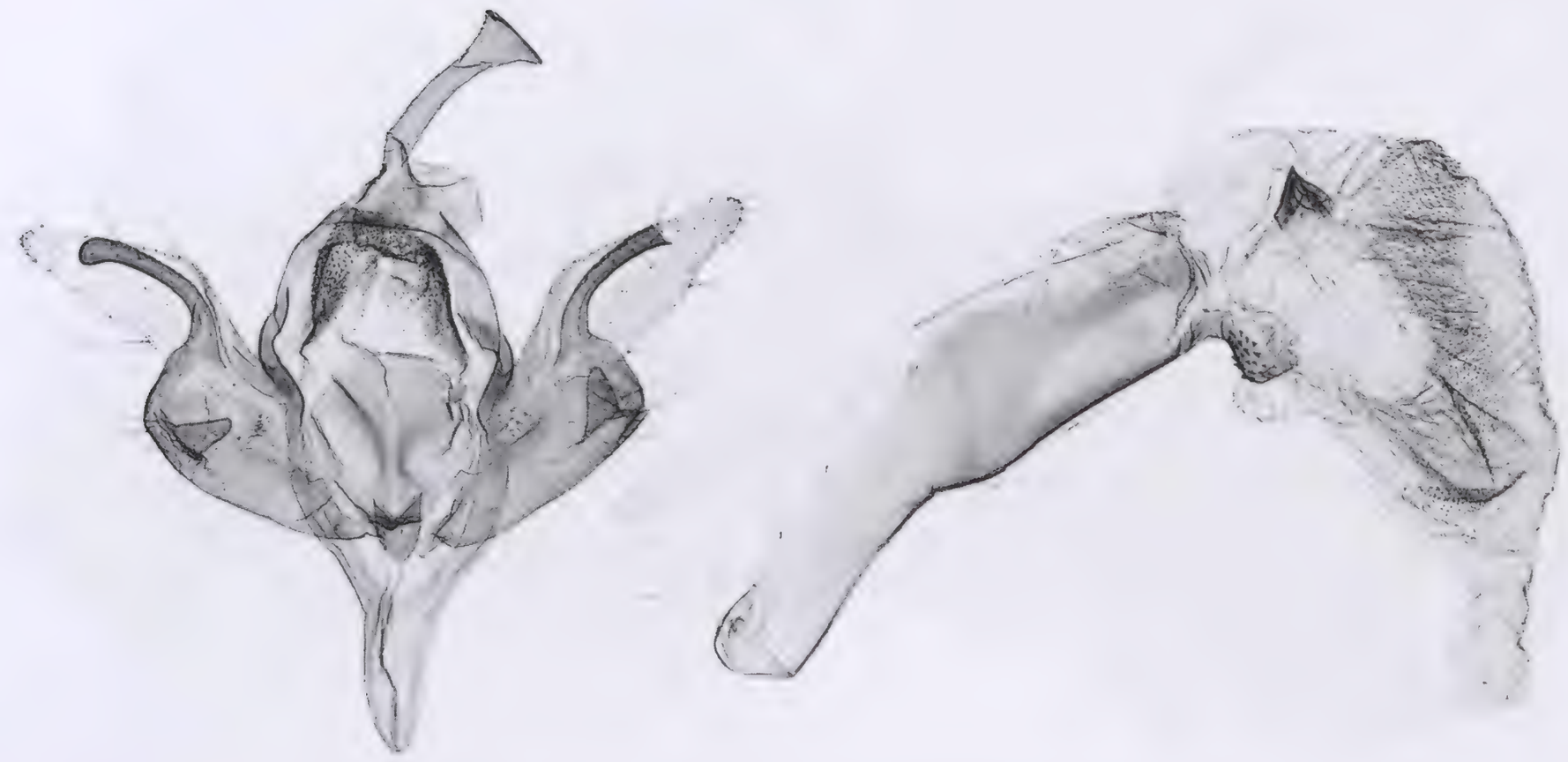
Gen. Fig. 8. *Hermonassa moorei* sp. n. female Paratype RL8570

Gen. Fig. 9. *Hermonassa tathabaya* sp. n. male Holotype RL6751



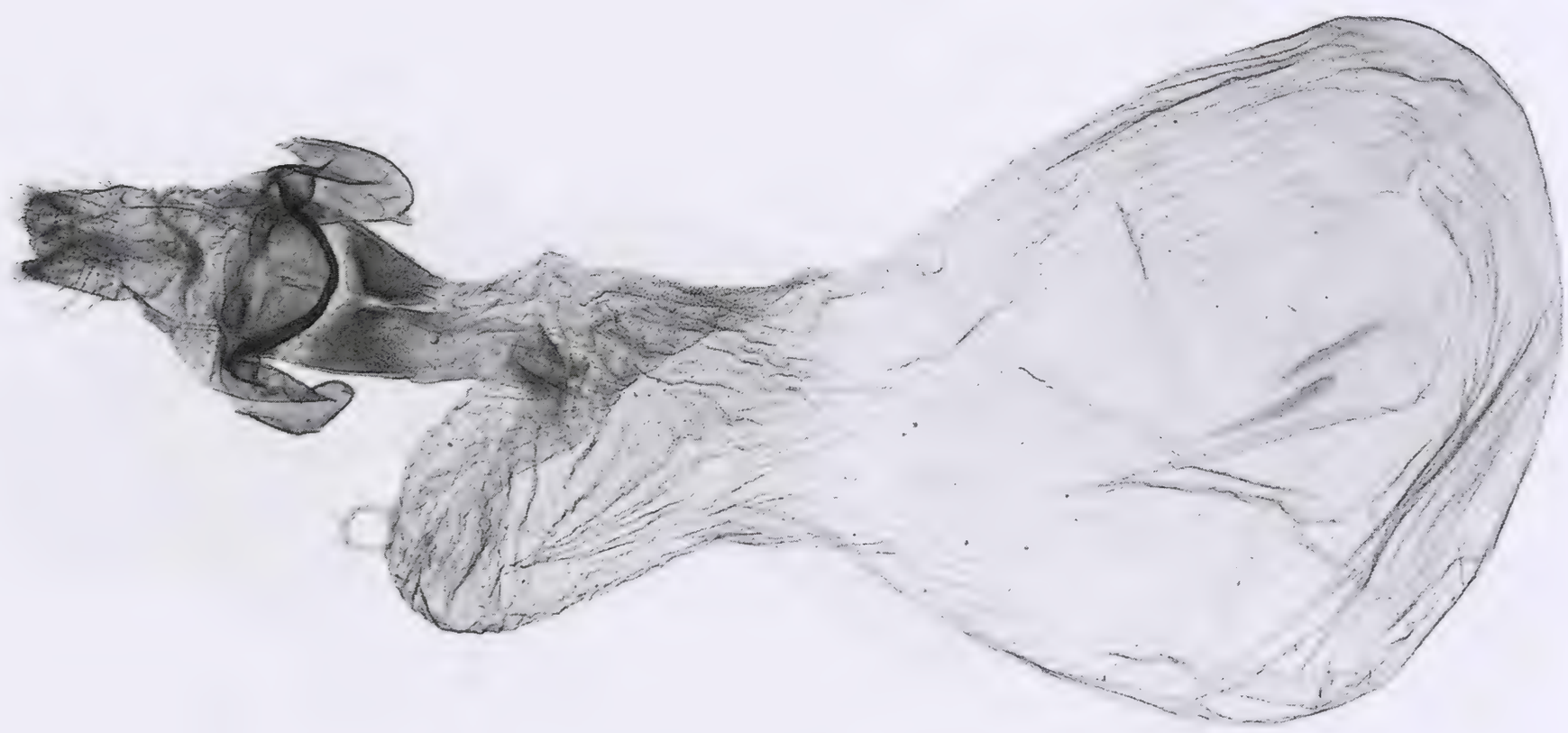
Gen. Fig. 10. *Hermonassa tathabaya* sp. n. male Paratype KST861

Gen. Fig. 11. *Hermonassa ayubia* sp. n. male Holotype KST863

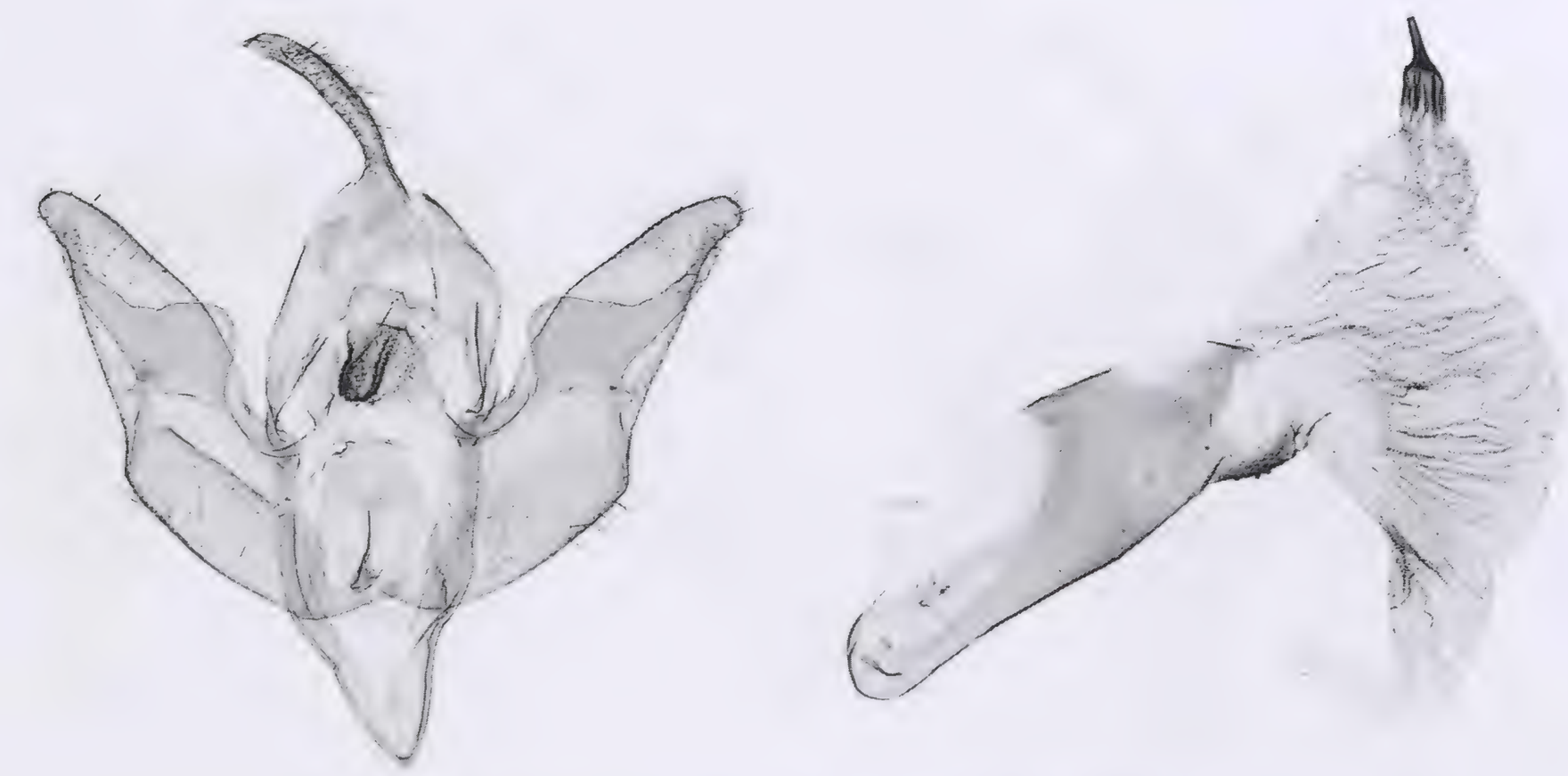


Gen. Fig. 12. *Hermonassa ayubia* sp. n. male Paratype RL6750

Gen. Fig. 13. *Hermonassa ayubia* sp. n. male Paratype RL7561

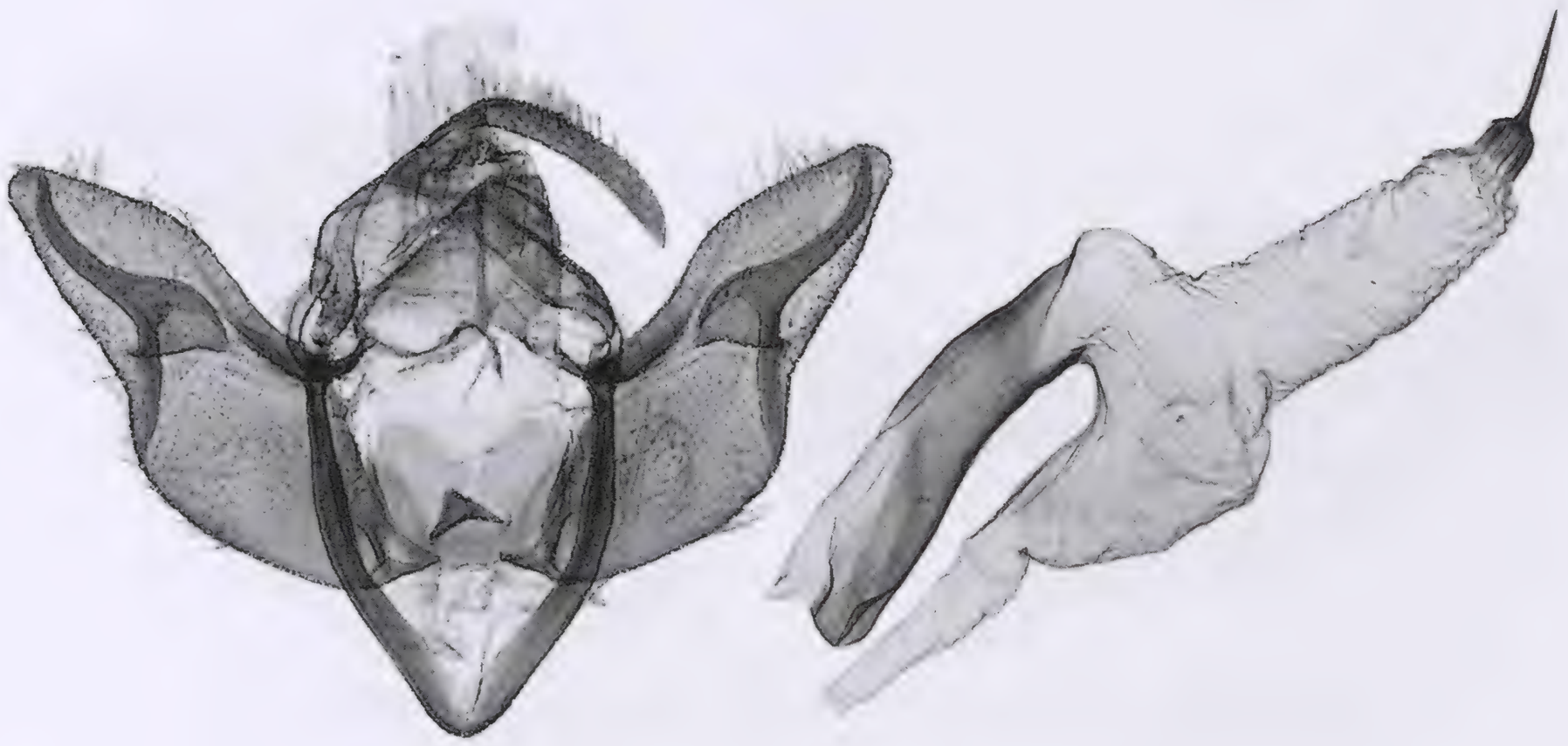


Gen. Fig. 14. *Hermonassa ayubia* sp. n. female Paratype KST869



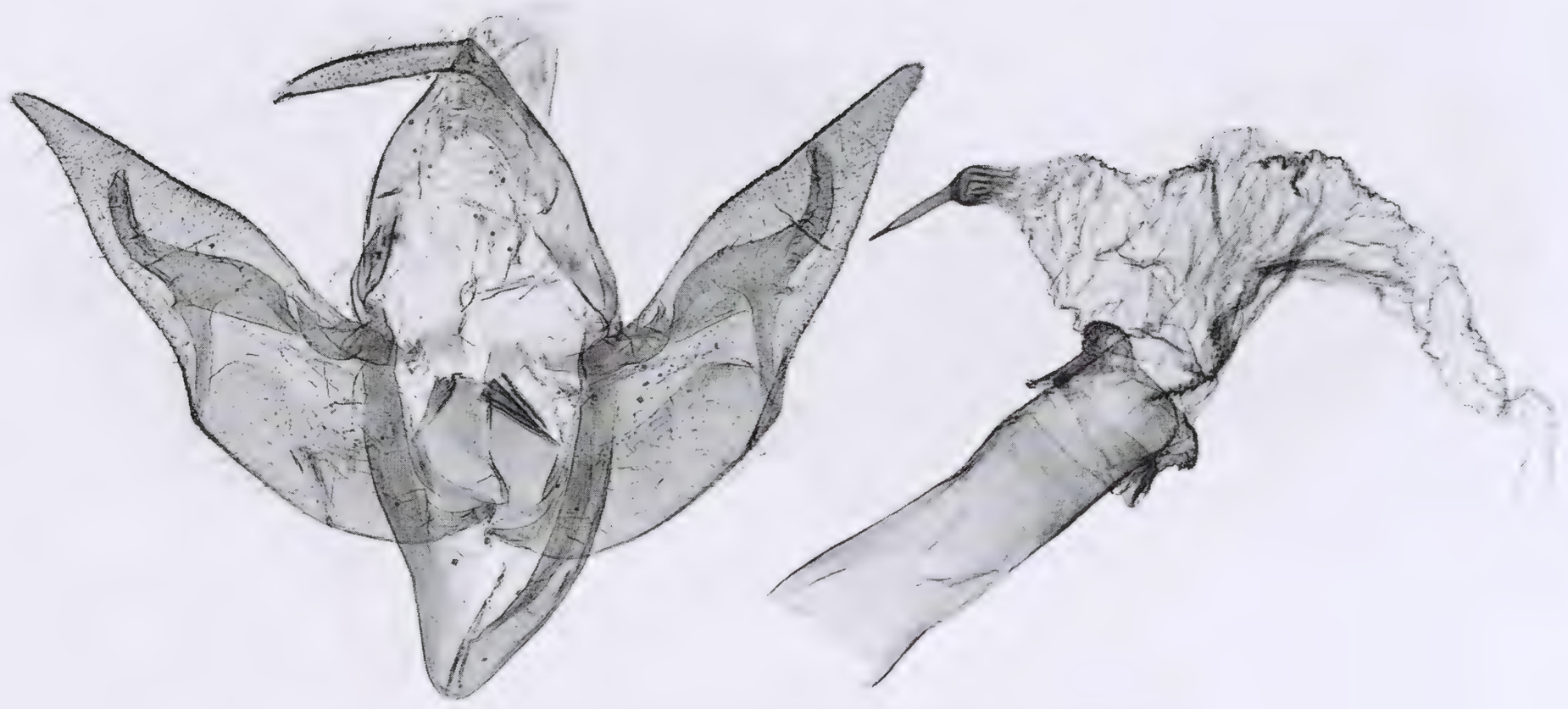
Gen. Fig. 15. *Hermonassa shizukoae* Sugi, 1995 male RL5504

Gen. Fig. 16. *Hermonassa shizokuae* Sugi, 1995 female



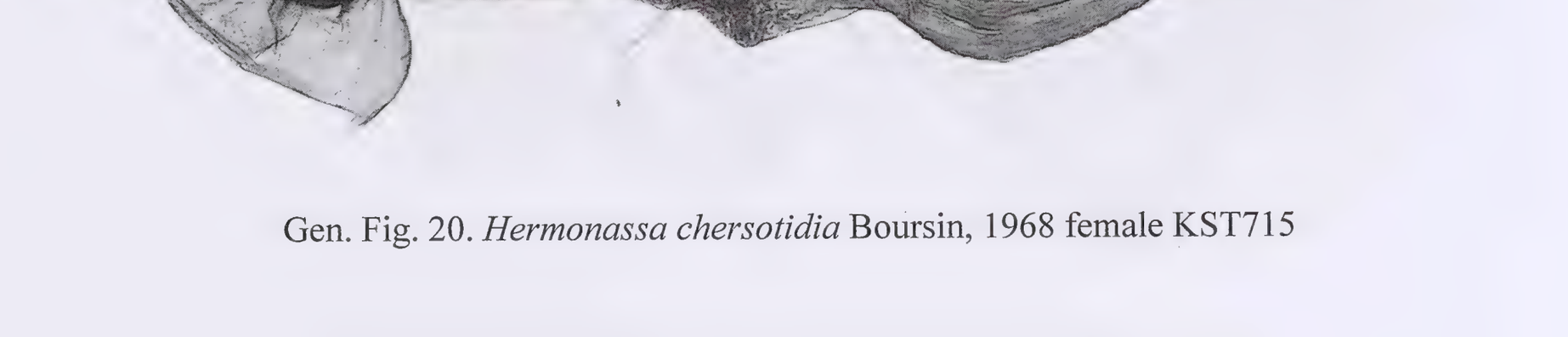
Gen. Fig. 17. *Hermonassa cyanolepis* Boursin, 1967 male

Gen. Fig. 18. *Hermonassa cyanolepis* Boursin, 1967 female

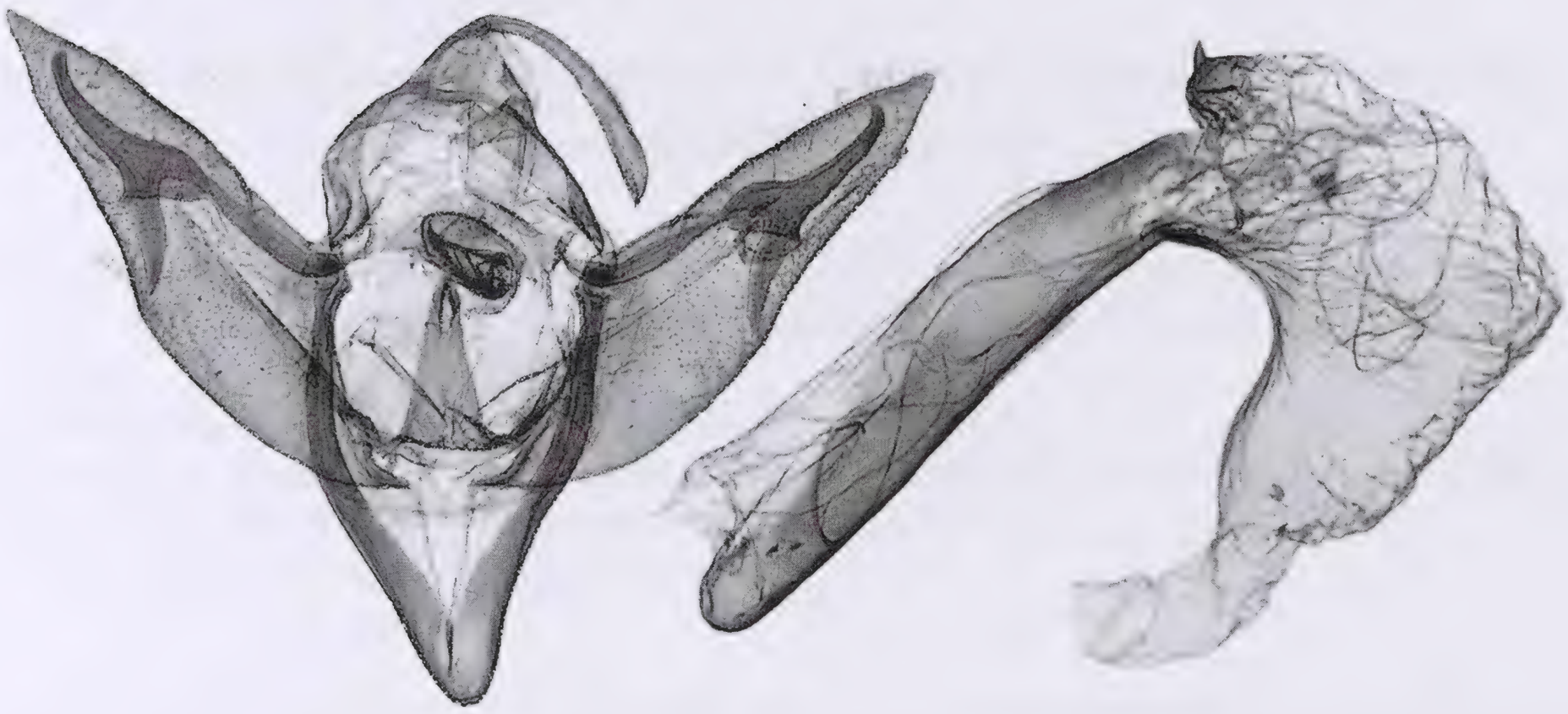


Gen. Fig. 19. *Hermonassa chersotidia* Boursin, 1968 male KST718

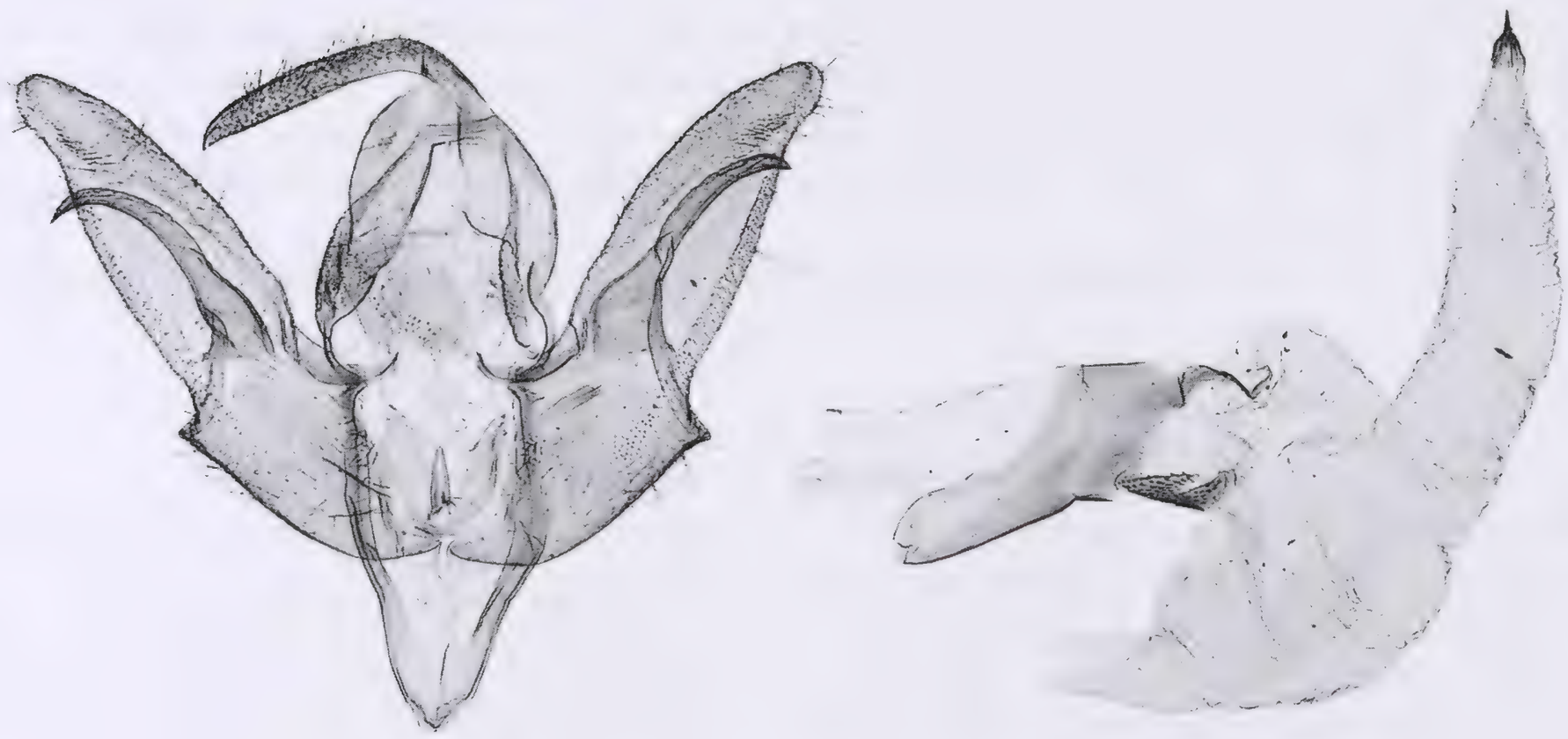
Gen. Fig. 20. *Hermonassa chersotidia* Boursin, 1968 female KST715



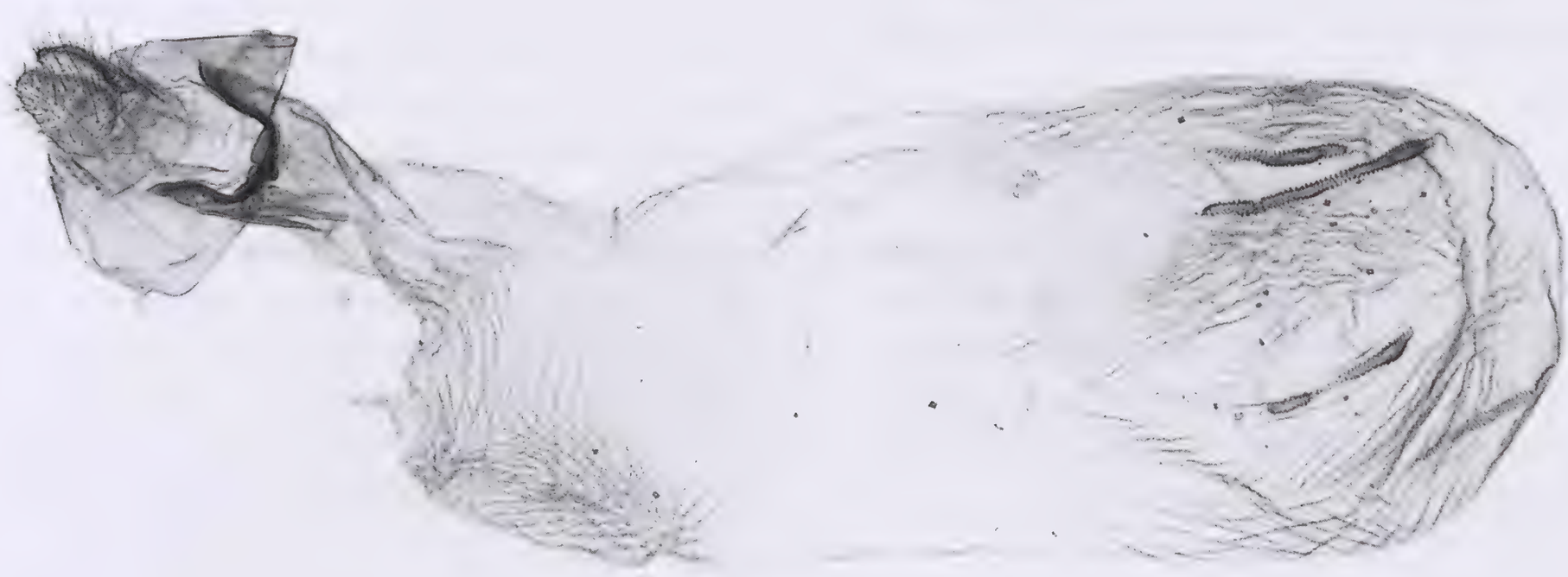
Gen. Fig. 21. *Hermonassa dispila* Boursin, 1967 male



Gen. Fig. 22. *Hermonassa dispila* Boursin, 1967 male



Gen. Fig. 23. *Hermonassa oxyspila* Boursin, 1968 male RL6196



Gen. Fig. 24. *Hermonassa oxyspila* Boursin, 1968 female KST722

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A revision of the trapdoor spider genus *Liphistius* (Mesothelae: Liphistiidae) in Peninsular Malaysia; part 2

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Abstract: The currently known species of the *Liphistius trang*-group in Peninsular Malaysia are revised on the basis of genital morphology and an identification key is given. *Liphistius thaleban* Schwendinger, 1990 and *L. rufipes* Schwendinger, 1995 are placed in the synonymy of *L. yangae* Platnick & Sedgwick, 1984. The previously unknown male of *L. kanthan* Platnick, in Platnick *et al.*, 1997 is described for the first time. *Liphistius kanthan* and *L. tempurung* Platnick, in Platnick *et al.*, 1997 are reported to occur together at the Tempurung Cave. *Liphistius buran* Schwendinger, sp. nov., an island species with a novel character of the palpal organ, is described from males and females. Information on and illustrations of intraspecific variation in most of these species is given together with data on biology and distribution. For selected *Liphistius* species in Malaysia a phylogenetic tree based on an analysis of COI sequences is presented and discussed in comparison with relationships inferred from morphological characters. Molecular data confirm the distinction between the *malayanus*-group and the *trang*-group in Malaysia, but, unlike an earlier interpretation of morphological evolution of genitalia, place species of the *trang*-group as basal to the *malayanus*-group.

Keywords: Arachnida - morphology - taxonomy - variation - biology - cave species - COI.

INTRODUCTION

The Malaysian *Liphistius* species belonging to the *malayanus*, *batuensis*, *tioman* and *linang* species-groups were treated in the first part of this revision (Schwendinger, 2017), here those of the *trang*-group follow. The *trang*-group was defined by Schwendinger (1990: 349) and later subdivided into six informal subgroups (species complexes) on the basis of genital characters (A: *L. dangrek, L. isan, L. nesioticus, L. ornatus, L. owadai, L. phileion, L. sayam, L. suwat*; B: *L. erawan, L. laoticus, L. ochraceus, L. onoi, L. pusohm, L. tham, L. thoranie*; C: *L. fuscus, L. phuketensis, L. schwendingeri*; D: *L. albipes, L. bicoloripes, L. buran* sp. nov., *L. castaneus, L. desultor, L. kanthan, L. laruticus, L. niphanae, L. sumatranus, L. trang, L. yangae*; E: *L. langkawi, L. murphyorum, L. thaleri*; F: *L. tenuis*. For species authorities and their references see the World Spider Catalog, 2019). This group is species-rich (currently 33 species, excluding the two new synonyms and including the new species described here) and widely distributed in the northern part of Malaysia, in southern, western, central and eastern Thailand, in southwestern Laos and in western Cambodia (unpublished data for the latter country). In addition to the single new species from Malaysia described here, several more from other SE-Asian countries await description.

In parallel to and independently from the morphology-based study of Malaysian *Liphistius* species by Schwendinger (2017), the second author carried out a study of selected *Liphistius* species of Malaysia for her M. Sc. thesis (Syuhadah, 2016) which included morphological and molecular data. The results of this study are presented here and compared with interspecies relationships inferred from morphological characters.

MATERIAL AND METHODS

Morphological methods: Morphological characters were studied and drawn mainly with a Zeiss SV11 stereomicroscope and an attached drawing tube, the vulval plates of the *L. yangae* paratypes with a Nikon Optiphot compound microscope and an attached drawing tube. SEM-micrographs of a critical-point-dried and

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gold-sputtered male palp were taken with a Zeiss DSM-940-A scanning electron microscope. Whenever possible, female copulatory organs were drawn and examined from exuviae. Vulvae of alcohol-preserved specimens were cleared of soft tissue with fine forceps, insect pins and a paintbrush with stiff bristles. Clearing in KOH was avoided, because it often leads to more or less pronounced deformation (bulging) of the vulval plate. The ventral cuticular wall of the female genital region was cut off with micro-scissors to allow an unimpeded view of the ventral side of the vulval plate. Terminology of genital structures follows Schwendinger & Ono (2011) and Schwendinger (2017); it partly differs from the terminology used in earlier publications on *Liphistius*. Opisthosomal tergites are numbered from anterior to posterior, with the anterior-most being tergite I. Body measurements are all in mm (for other measurements the units are given) and were taken on the dorsal side, between midpoint of anterior and posterior margin. Total length includes chelicerae and anal tubercle. The carapace length was measured with the carapace in a slightly forward-inclined position so that the anterior and posterior margins were at the same focal plane. Leg and palp measurement are given in the following manner: total length (femur + patella + tibia + metatarsus + tarsus). In the paragraph "Variation" only taxonomic characters considered to be relevant are mentioned. In the figure legends references to illustrations that are to the same scale are separated by commas, references to illustrations of different scales by semi-colons.

The primary type specimens of several taxa treated here were not re-examined because: (a) those of the "old species" (*L. desultor*) were redescribed and illustrated in Haupt (1983) and Platnick & Sedgwick (1984); (b) the descriptions and illustrations of the other taxa (*L. kanthan, L. langkawi, L. laruticus, L. murphyorum, L. yangae*) are considered sufficient and reliable, and thus a re-examination of the types is not regarded as necessary; (c) some of the new specimens presented here were collected at (or very close to) the type localities of their respective species (*L. kanthan, L. langkawi*, *L. muphyorum*, *L. yangae*).

Male spiders of the genus *Liphistius* possess a unique character: an embolus (here called "embolus proper") that is deeply split into a thick sclerotised part (strengthened by longitudinal ribs) and a thin membranous (hyaline) part. On one side (the prolateral or proventral side) the split reaches down to the base of the embolus proper. On the other (retrodorsal or prodorsal) side the split does not reach the base of the embolus proper but is drawn out into a more or less widely extended membranous fold, the major embolic fold (Fig. 14F-G; Schwendinger, 2017: fig. 3). This condition we call a deeply split embolus, and to our knowledge it is not found in any other spiders. In the *trang*-group males both embolic parts are distinctly apart and the division is wide (Schwendinger, 1990: figs 60-62; Schwendinger, 2017: fig. 3A, C, E, G), whereas in other species groups both parts are close to each other and the division is narrow [however, embolus morphology is not uniform in these species groups – compare e.g. *bristowei*-group (Schwendinger, 1990: figs 57-59) with *malayanus*-group (Schwendinger, 2017: fig. 3B, D, F, H) – and thus these are not necessarily most closely related to each other]. In the Heptathelinae the embolus is similar to that of *Liphistius* and certainly homologous, but of different build. Most importantly: the entire embolus is sclerotised, there is no membranous part. The thin apical rim of the heptatheline embolus opening is usually hyaline or partly hyaline (e.g. Logunov & Vahtera, 2017: figs 14, 17), but there is no separate membranous embolic part. In a few Heptathelinae and in most Opisthothelae the opening of the spermophor is a simple round pore (e.g. Haupt, 2003: fig. 51C-E), in many others the embolus is compressed and the opening is a long thin slit (e.g. Schwendinger & Ono, 2011: figs 6, 8-9). In some species this slit has a straight apical margin (e.g. Haupt, 2003: fig. 48C; Schwendinger & Ono, 2011: figs 6, 26), in others the distal margin is more or less distinctly invaginated (e.g. Haupt, 2003: fig. 49A-B; Logunov & Vahtera, 2017: figs 7, 9, 12, 14, 17, 20), but judging from heptatheline males we have examined it is not split. What appears to be a deep split down to the base on one side of the embolus in heptatheline males shown in Ono (1997: figs 1, 15; 1998: figs 6, 21) needs to be re-examined; it may be a step and not a split.

Consequently our character state coding for embolus morphology (see Table 1 and Fig. 17) is: (A, white) entirely sclerotised, undivided and tube-like; (B, blue) entirely sclerotised, undivided and compressed, with straight distal margin; (C, green) entirely sclerotised, undivided and compressed, with more or less strongly invaginated distal margin; (D, yellow) partly sclerotised, narrowly divided into sclerotised and membranous parts; (E, black) partly sclerotised, widely divided into sclerotised and membranous parts.

Molecular methods: The molecular analysis includes COI sequence data from 45 ingroup terminals: sequences from 40 *Liphistius* specimens from Peninsular Malaysia were generated during the course of the second author's research work for her M. Sc. (Syuhadah, 2016), and sequences from five additional *Liphistius* specimens from Laos, Malaysia and Thailand were obtained from GenBank (see Table 1 for detailed data and references). Thirty-six specimens of the closely related sub-family Heptathelinae, as well as seven specimens of the mygalomorph families Atypidae (2 spp.), Halonoproctidae (4 spp.) and Ctenizidae (1 sp.) were selected as out-groups. The data for these species were also downloaded from GenBank (see Table 1 for references).

DNA extraction, polymerase chain reaction and sequencing: The specimens sequenced in the course of this study were collected in Peninsular Malaysia and preserved in 70% ethanol at room temperature, except

for the dissected right fourth leg of each specimen which was preserved in absolute ethanol at minus 20°C. One to three legs of each specimen were stored individually in microcentrifuge tubes filled with absolute ethanol and kept at minus 20°C prior to DNA analysis.

The whole genomic DNA was extracted from one or two legs per individual using the I-genomic CTB DNA Extraction Kit protocol for animal tissue (iNtRON Biotechnology, Seongnam, South Korea). A fragment of the mitochondrial cytochrome c oxidase subunit I gene (COI) was amplified using the universal primer pair LCO1490, HCO2180 (Folmer *et al.*, 1994). Amplifications of the COI was performed in a final volume of 30 µL containing 2.40 µL dNTPs, 3.00 µL of 10X i-Taq PCR buffer, 0.60 µL of i-Taq™ plus DNA Polymerase (iNtRON Biotechnology, Seongnam, South Korea); 15.0 µL ultra-pure water; 10 pmol of each forward and reverse primer; and 7.5 µL genomic DNA.

Table 1. Detailed data of the specimens included in the phylogenetic analysis, with GenBank registration numbers for COI sequences (Fig. 16) and character coding for embolus types (Fig. 17).

	FAMILY/SUB-FAMILY	Specimen Code	Genus	Species	Sex	Locality	GenBank accession no.	Reference	Embolus type
INGROUP	LIPHISTIINAE	LS013	*Liphistius*	*malayanus*	♀	Ampang Forest Reserve, Selangor	KR017711	this study	D
INGROUP	LIPHISTIINAE	LS014	*Liphistius*	*malayanus*	♀	Ampang Forest Reserve, Selangor	KR017712	this study	D
INGROUP	LIPHISTIINAE	LS020	*Liphistius*	*malayanus*	♀	Ulu Bendul Amenity Forest, Negeri Sembilan	KR028500	this study	D
INGROUP	LIPHISTIINAE	LS114	*Liphistius*	*malayanus*	♀	Ulu Bendul Amenity Forest, Negeri Sembilan	KR017713	this study	D
INGROUP	LIPHISTIINAE	LS012	*Liphistius*	*malayanus*	♀	Fraser's Hill, Pahang	KR028501	this study	D
INGROUP	LIPHISTIINAE	LS008	*Liphistius*	*malayanus*	♀	Fraser's Hill, Pahang	KR028502	this study	D
INGROUP	LIPHISTIINAE	LS009	*Liphistius*	*malayanus*	♂	Genting Highland, Pahang	KR028504	this study	D
INGROUP	LIPHISTIINAE	LS011	*Liphistius*	*malayanus*	♀	Genting Highland, Pahang	KR028503	this study	D
INGROUP	LIPHISTIINAE	LS010	*Liphistius*	*malayanus*	♀	Genting Highland, Pahang	KR028505	this study	D
INGROUP	LIPHISTIINAE	LS001	*Liphistius*	*malayanus*	♀	Ulu Gombak Forest Reserve, Selangor	KR028506	this study	D
INGROUP	LIPHISTIINAE	LS018	*Liphistius*	*malayanus*	♀	Ulu Gombak Forest Reserve, Selangor	KR028507	this study	D
INGROUP	LIPHISTIINAE	LS019	*Liphistius*	*malayanus*	♀	Ulu Gombak Forest Reserve, Selangor	KR028508	this study	D
INGROUP	LIPHISTIINAE	LS098	*Liphistius*	*malayanus*	juvenile	Kemensah Waterfall, Selangor	KR028537	this study	D
INGROUP	LIPHISTIINAE	LS021	*Liphistius*	*desultor*	♀	Penang Botanic Gardens, Penang	KR028514	this study	E
INGROUP	LIPHISTIINAE	LS034	*Liphistius*	*desultor*	♀	Penang Botanic Gardens, Penang	KR028515	this study	E
INGROUP	LIPHISTIINAE	LS036	*Liphistius*	*desultor*	♀	Penang Botanic Gardens, Penang	KR028516	this study	E
INGROUP	LIPHISTIINAE	LS053	*Liphistius*	*desultor*	♀	Teluk Bahang Amenity Forest, Penang	KR028517	this study	E
INGROUP	LIPHISTIINAE	LS054	*Liphistius*	*desultor*	juvenile	Teluk Bahang Amenity Forest, Penang	KR028518	this study	E
INGROUP	LIPHISTIINAE	LS022	*Liphistius*	*murphyorum*	♂	Teluk Bahang Amenity Forest, Penang	KR028519	this study	E
INGROUP	LIPHISTIINAE	LS035	*Liphistius*	*murphyorum*	♀	Teluk Bahang Amenity Forest, Penang	KR028520	this study	E

	FAMILY/SUB-FAMILY	Specimen Code	Genus	Species	Sex	Locality	GenBank accession no.	Reference	Embolus type
INGROUP	LIPHISTIINAE	LS037	*Liphistius*	*murphyorum*	♀	Teluk Bahang Amenity Forest, Penang	KR028521	this study	E
INGROUP	LIPHISTIINAE	LS093	*Liphistius*	*endau*	juvenile	Endau-Rompin National Park, Johor	KR028522	this study	D
INGROUP	LIPHISTIINAE	LS094	*Liphistius*	*endau*	♀	Endau-Rompin National Park, Johor	KR028523	this study	D
INGROUP	LIPHISTIINAE	LS148	*Liphistius*	*endau*	♀	Endau-Rompin National Park, Johor	KR028524	this study	D
INGROUP	LIPHISTIINAE	LS140	*Liphistius*	*endau*	♀	Kota Tinggi Waterfall, Johor	KR028525	this study	D
INGROUP	LIPHISTIINAE	LS141	*Liphistius*	*endau*	♀	Kota Tinggi Waterfall, Johor	KR028526	this study	D
INGROUP	LIPHISTIINAE	LS125	*Liphistius*	*laruticus*	♀	Maxwell Hill, Perak	KR028527	this study	E
INGROUP	LIPHISTIINAE	LS128	*Liphistius*	*laruticus*	♀	Maxwell Hill, Perak	KR028528	this study	E
INGROUP	LIPHISTIINAE	LS136	*Liphistius*	*laruticus*	♀	Maxwell Hill, Perak	KR028529	this study	E
INGROUP	LIPHISTIINAE	LS142	*Liphistius*	sp.	♀	Lake Kenyir, Terengganu	KR028530	this study	?
INGROUP	LIPHISTIINAE	LS143	*Liphistius*	sp.	♂	Lake Kenyir, Terengganu	KR028531	this study	D
INGROUP	LIPHISTIINAE	LS049	*Liphistius*	sp.	juvenile	Pasir Raja Forest Reserve, Terengganu	KR028535	this study	?
INGROUP	LIPHISTIINAE	LS051	*Liphistius*	sp.	juvenile	Pasir Raja Forest Reserve, Terengganu	KR028536	this study	?
INGROUP	LIPHISTIINAE	LS059	*Liphistius*	sp.	juvenile	Felda Tekam, Pahang	KR028538	this study	?
INGROUP	LIPHISTIINAE	LS067	*Liphistius*	sp.	juvenile	Felda Tekam, Pahang	KR028539	this study	?
INGROUP	LIPHISTIINAE	LS080	*Liphistius*	cf. *desultor*	juvenile	Ulu Kinta Amenity Forest, Perak	KR028532	this study	E
INGROUP	LIPHISTIINAE	LS081	*Liphistius*	cf. *desultor*	♀	Ulu Kinta Amenity Forest, Perak	KR028533	this study	E
INGROUP	LIPHISTIINAE	LS082	*Liphistius*	cf. *desultor*	♀	Ulu Kinta Amenity Forest, Perak	KR028534	this study	E
INGROUP	LIPHISTIINAE	LS002	*Liphistius*	sp.	♂	Parit Falls Forest Eco Park, Cameron Hl., Pahang	KR028511	this study	D
INGROUP	LIPHISTIINAE	LS003	*Liphistius*	sp.	♂	Parit Falls Forest Eco Park, Cameron Hl., Pahang	KR028512	this study	D
INGROUP	LIPHISTIINAE	-	*Liphistius*	*laoticus*	-	Laos, Champasak, Etu Waterfall	KP229833	Xu *et al.*, 2015b	E
INGROUP	LIPHISTIINAE	-	*Liphistius*	*laoticus*	-	Laos, Champasak, Fane Waterfall	KP229884	Xu *et al.*, 2015b	E
INGROUP	LIPHISTIINAE	-	*Liphistius*	*erawan*	-	Thailand	JQ407803	Podsiadlowski *et al.* (unpublished)	E
INGROUP	LIPHISTIINAE	-	*Liphistius*	*malayanus*	-	Malaysia, Pahang, Genting Highlands	KP229904	Xu *et al.*, 2015b	D
INGROUP	LIPHISTIINAE	-	*Liphistius*	*malayanus*	-	Malaysia, Pahang, Genting Highlands	KP229862	Xu *et al.*, 2015b	D
OUTGROUP	HEPTATHELINAE	-	*Ganthela*	*cipingensis*	-	China, Jingganshan, Jiangxi	KP229886	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Ganthela*	sp.	-	China, Wangjiangshan, Fujian	KP229899	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Heptathela*	*amamiensis*	-	Japan, Amami, Kyushu	KP229858	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Heptathela*	*higoensis*	-	Japan, Miyazaki, Kyushu	KP229890	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Heptathela*	*kimurai*	-	Japan, Shiroyama, Kyushu	KP229828	Xu *et al.*, 2015b	C

	FAMILY/SUB-FAMILY	Specimen Code	Genus	Species	Sex	Locality	GenBank accession no.	Reference	Embolus type
OUTGROUP	HEPTATHELINAE	-	*Qiongthela*	*baishensis*	-	China, Baisha, Hainan	KP229805	Xu *et al.*, 2015b	B
OUTGROUP	HEPTATHELINAE	-	*Qiongthela*	sp.	-	China, Bawangling, Hainan	KP229897	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Qiongthela*	sp.	-	China, Hainan, Jianfeng	KP229901	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Ryuthela*	*ishigakiensis*	-	Japan, Okinawa, Iriomotejima	KP229823	Xu *et al.*, 2015b	B
OUTGROUP	HEPTATHELINAE	-	*Ryuthela*	*nishihirai*	-	Japan, Taira, Okinawa	KP229830	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Ryuthela*	*sasakii*	-	Japan, Tokashiki, Okinawa	KP229813	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Sinothela*	*heyangensis*	-	China, Shanxi	KP229846	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Sinothela*	*luotianensis*	-	China, Luotian, Hubei	KP229881	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Songthela*	*goulouensis*	-	China, Gouloufeng, Hunan	KP229824	Xu *et al.*, 2015b	B
OUTGROUP	HEPTATHELINAE	-	*Songthela*	*hangzhouensis*	-	China, Hengshan, Hunan	KP229802	Xu *et al.*, 2015b	B
OUTGROUP	HEPTATHELINAE	-	*Songthela*	*sapana*	-	Vietnam, Sa Pa	KP229882	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Sinothela*	*sinensis*	-	China, Yiyuan, Shandong	KP229871	Xu *et al.*, 2015b	B
OUTGROUP	HEPTATHELINAE	-	*Songthela*	*wosanensis*	-	China, Eschan, Yunnan	KP229836	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Songthela*	sp.	-	China, Chengxi, Anjiang, Hunan	KP229850	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Songthela*	sp.	-	China, Dali, Hunan	KP229818	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Songthela*	sp.	-	China, Kumming, Yunnan	KP229883	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Songthela*	sp.	-	China, Lichuan, Hubei	KP229851	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Songthela*	sp.	-	China, Western Hill, Yunan	KP229906	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*abca*	-	Vietnam, Lao Cai	KP229817	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*cucphuongensis*	-	Vietnam, Cuc Phuong	KT767580	Xu *et al.*, 2016	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*cucphuongen*sis	-	Vietnam, Cuc Phuong	KP229855	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*hongkong*	-	China, Hong Kong	KP229867	Xu *et al.*, 2015b	A
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*nahang*	-	Vietnam, Tuyen Quang, Na Hang	KY417118	Vahtera & Logunov, 2017	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*nahang*	-	Vietnam, Tuyen Quang, Na Hang	KY417119	Vahtera & Logunov, 2017	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*tomokunii*	-	Vietnam, Tam Dao	KP229912	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	*tonkinensis*	-	Vietnam, Luc Nam	KP229840	Xu *et al.*, 2015b	C
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	sp.	-	China, Mt Yuelu, Hunan	KP229841	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	sp.	-	Vietnam, Yenbai	KP229853	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	sp.	-	China, Chenzhou, Hunan	KP229905	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	sp.	-	China, Ji'an, Jiangxi	KP229856	Xu *et al.*, 2015b	?
OUTGROUP	HEPTATHELINAE	-	*Vinathela*	sp.	-	China, Jinggangshan, Jiangxi	KP229915	Xu *et al.*, 2015b	?
OUTGROUP	ATYPIDAE	-	*Atypus*	*yajuni*	-	China, Mojiang, Yunnan	KP208887	Xu *et al.*, 2015b	A
OUTGROUP	ATYPIDAE	-	*Atypus*	*heterothecus*	-	China, Luohu, Shenzhen	KP208882	Xu *et al.*, 2015b	A
OUTGROUP	HALONOPROCTIDAE	-	*Conothele*	*taiwanensis*	-	Laos, Oudom Xai Province	KP208890	Xu *et al.*, 2015b	A
OUTGROUP	HALONOPROCTIDAE	-	*Cyclocosmia*	*ricketti*	-	China, Hangzhou, Zhejiang	KP208889	Xu *et al.*, 2015b	A
OUTGROUP	CTENIZIDAE	-	*Cyrtocarenum*	*grajum*	-	-	KU854132	Kornilios *et al.*, 2016	A
OUTGROUP	HALONOPROCTIDAE	-	*Latouchia*	*typica*	-	China, Shenzhen	KP208888	Xu *et al.*, 2015b	A
OUTGROUP	HALONOPROCTIDAE	-	*Ummidia*	*picea*	-	Spain, Murcia, Alberca, El Valle	KT756335	Opatova *et al.* (unpublished)	A

PCR parameters included an initial 95°C denaturation followed by 35 cycles of 45 seconds at 95°C, 45 seconds at 56.3°C, 45 seconds at 72°C with a final 5 minute extension at 72°C. The PCR products were purified and directly sequenced using 3730XL Genetic Analyzer (Applied Biosystems).

Prior to data analysis all sequence reads were checked against chromatograph data using the Sequence Scanner v1.0 (Applied Biosystem™, California, USA) to ensure a high quality of the sequence and to remove ambiguous bases. Each chromatogram for the forward and reverse sequence for each sample was checked by eye for errors and assembled using MEGA 5.2 (Tamura *et al.*, 2011). All nucleotide sequences were then aligned using the Clustal W algorithm included in MEGA and were trimmed to a length of 552 bp. The aligned COI sequences were submitted to the GenBank database (see Table 1 for accession numbers and detailed data).

Phylogenetic analysis: The COI sequences were divided into three partitions corresponding to the three codon positions. The substitution model GTR+I+G, chosen on the basis of the Bayesian information criterion (BIC) in jMODELTEST 2.1.10 (Darriba *et al.*, 2012), was applied to the three partitions independently. We conducted Bayesian-inference (BI) analysis (Huelsenbeck & Ronquist, 2001) in MrBayes 3.2.7 (Ronquist *et al.*, 2012) by running Markov chain Monte Carlo (MCMC) in two independent runs of four chains. Trees were sampled every 1000 generations and the two runs converged after 7,202,000 generations. The first 25% of the generated trees were discarded, as confirmed by visualisation of the log likelihood trace and the average standard deviation of the split frequencies being <0.01. Posterior probabilities were calculated and reported on a 50% majority-rule consensus tree of the post-burnin sample.

Usefulness of COI: Mitochondrial DNA evolves more rapidly (two to more than twenty time faster) than nuclear DNA throughout the animal kingdom (Allio *et al.*, 2017). It is thus generally regarded as a poor candidate to evaluate phylogenetic relationships at the deeper hierarchical levels, but can still be considered for studies of recently evolved taxonomic groups (Moore, 1995). For instance, Hwang & Kim (1999) consider COI loci suitable to infer intrafamilial and intrageneric phylogenetic relationships in Arthropoda. Nevertheless, evaluating phylogenies based on a single mitochondrial gene is questionable, and a multilocus analysis including both mitochondrial and nuclear markers is always more appropriate for inferring a phylogeny (Rubinoff & Holland, 2005). However, in the present case our aim was not to provide an accurate assessment of the phylogenetic relationships within Liphistiidae, but rather to determine if molecular data will recover clades congruent with species groups diagnosed by embolus morphology. The DNA barcoding region of the mitochondrial cytochrome *c* oxidase subunit I has already been used with success to delimit species in Liphistiidae (Xu *et al.*, 2015a) as well as in other spider groups (Hamilton *et al.*, 2011; Čandek & Kuntner, 2015), and thus appears to be a suitable tool for confirming the phylogenetic importance of embolus morphology in the genus *Liphistius*.

Character optimization: Character states pertaining to the morphology of the embolus were mapped onto the Bayesian cladogram with Mesquite version 2.75 (Maddison & Maddison, 2011) using the parsimony criterion. The characters were treated as ordered because there is a clear evolutionary sequence from a simple tube-like, completely sclerotised embolus developing into more complex and divided structures with a sclerotised and a membranous part. The consistency index and retention index were calculated and are provided in the corresponding figure.

Museum acronyms: AMNH = American Museum of Natural History, New York, USA; BMNH = Natural History Museum, London, UK (formerly British Museum of Natural History); MHNG = Muséum d'histoire naturelle de la Ville de Genève, Switzerland; SMF = Senckenberg Museum, Frankfurt, Germany; NHMS = Lee Kong Chian Natural History Museum, Singapore; ZMC = Zoological Museum, University of Copenhagen, Denmark.

Other abbreviations used in the text: AME = anterior median eyes, CDO = central dorsal opening (macropore) of poreplate. Additional abbreviations are explained in the corresponding figure legends.

TAXONOMIC PART

The *trang*-group

Diagnosis: Small to large species (carapace length of males 4.36-12.04, carapace width 3.64-10.99). Males are distinguished from those of all other species groups in *Liphistius* by a deeply split embolus proper with the sclerotised part (strengthened by three longitudinal ridges) and the membranous part being widely divided and connected by a short but very wide major embolic fold on the retrolateral side (Schwendinger, 2017: fig. 3A, C, E, G), as well as by a pronounced, usually quite long para-embolic plate which is not or only slightly inclined from the axis of the embolus proper. Fully grown females (but not all small ones) are distinguished from those of other species groups in Malaysia by possessing a small CDO, a small receptacular cluster (never protruding beyond the anterior margin of the poreplate), more or less pronounced (in some species reduced or absent) lateral processes on the ventral rim of the poreplate, and a quite short posterior stalk which is rarely wider than the poreplate and rarely constricted at its base. Females and large juvenile males of some species possess orange-coloured proximal limb articles (i.e. always the femora; in at least one species in Thailand also the patellae and tibiae) and parts of the carapace (Fig. 1A).

Species included: *Liphistius albipes, L. bicoloripes, L. buran* sp. nov., *L. castaneus, L. dangrek, L. desultor, L. erawan, L. fuscus, L. isan, L. kanthan, L. langkawi, L. laoticus, L. laruticus, L. murphyorum, L. nesioticus, L. niphanae, L. ochraceus, L. onoi, L. ornatus, L. owadai, L. phileion, L. phuketensis, L. pusohm, L. sayam, L. schwendingeri, L. sumatranus, L. suwat, L. tenuis, L. thaleri, L. tham, L. thoranie, L. trang, L. yangae.* For species authorities and their references see the World Spider Catalog (2019).

Relationships: The relationships with other species groups are unclear. Widely divided embolic parts as present in species of this group are neither found in other congeners nor in other spiders, and this character state is thus possibly a synapomorphy. Similarities in the shape of the vulval plates indicate a close relationship with species of the *bristowei*-group. In contrast to embolus morphology, COI data indicate that the *trang*-group is parapyletic and that the *malayanus*-group is nested in it (see Figs 16-17 and paragraph "Molecular part").

Distribution: In Malaysia all known species of this group are only found in the northern and northwestern parts of the country, from the Thai-Malaysian border in Perlis in the north to Gunung Stong in Kelantan in the east to Pangkor Island in Perak in the south (Fig. 2, localities 1, 6-7, 10-18). In Thailand this group is widely distributed and species-rich in the southern, central and eastern regions of the country. In Laos at least two species (one of them also occurring in Thailand; Schwendinger, 2013) are found in the south, and in Cambodia at least two species occur in the west (Schwendinger, unpublished data).

Liphistius yangae Platnick & Sedgwick, 1984

Figs 3-4

Liphistius yangae Platnick & Sedgwick, 1984: 14, figs 22-23 (description of female).
Liphistius thaleban Schwendinger, 1990: 345-347, figs 50-56 (description of male and female). **New synonym.**
Liphistius rufipes Schwendinger, 1995: 143-144, figs 1-6, 9-11 (description of male and female). **New synonym.**

Types: NHMS (previously deposited in the Zoological Reference Collection of the National University of Singapore); female holotype (not examined); Malaysia, Perlis, Kaki Bukit; collector unknown; December 1938. – NHMS and AMNH; 13 mostly young female paratypes (4 of them, NHMS ZRC.1983.11.11.1, examined); same data as for holotype. – MHNG; male holotype and 4 female paratypes of *L. thaleban* syn. nov. (examined); Thailand, Thaleban N.P.; 20.VIII.1986; leg. P.J. Schwendinger. – MHNG; male holotype, 3 female paratypes of *L. rufipes* syn. nov. (examined); Thailand, Than To Waterfall.; 2.II.1991 and 19.I.1994; leg. P.J. Schwendinger. – 1 male paratype of *L. rufipes* syn. nov. (examined); Malaysia, Perak, E of Bukit Baring; 8.II.1991; leg. P.J. Schwendinger.

Other material examined: MHNG; 1 male (matured 20.XII.1995), 1 juv. male, 1 female; Thailand, Songkhla Prov., Tone Nga Chang Waterfall, about 15 km W of Had Yai, 160 m; 2.II.1995; leg. P.J. Schwendinger. – MHNG, sample THA-99/4; 2 males (matured 20.IV.2003 and 19.IV.2004, respectively), 1 penultimate male, 2 females (last moulted 16.X.2002 and 7.II.2003, respectively); Thailand, Pattani Prov., Sankhalakhierie Mountains; 22.X.1999; leg. P.J. Schwendinger. – MHNG, sample THA-11/08; 1 female

Fig. 1. *Liphistius* spp. females in front of burrow with door closed (A) and at burrow entrance with door open (B). (A) Not fully-grown spider, probably belonging to *L. desultor*, at an undisclosed locality near Ipoh (© Fletcher & Baylis). (B) *L. kanthan* inside Kanthan Cave (© N. Syuhadah).

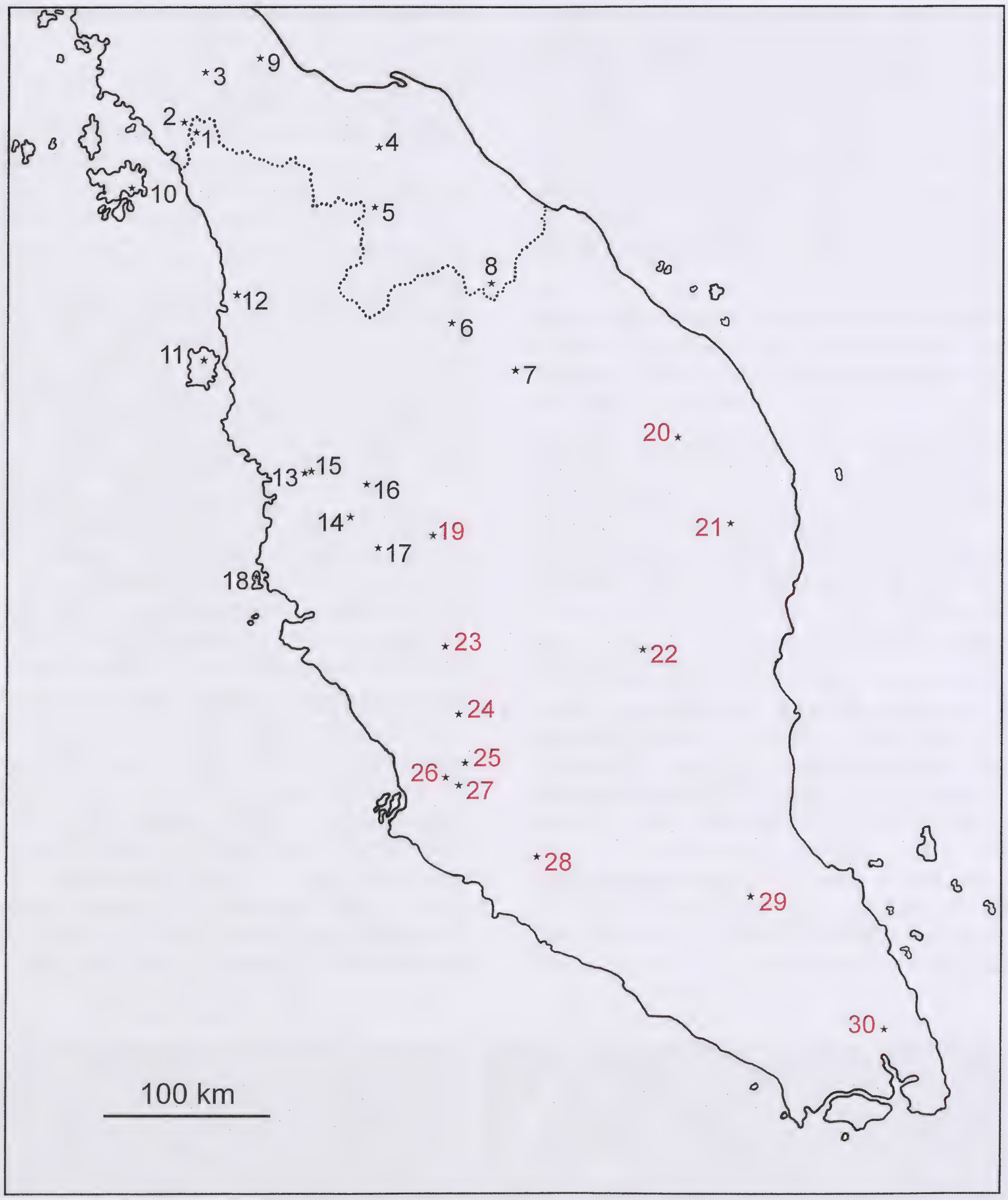

Fig. 2. Localities of *Liphistius* specimens of the *trang*-group in Peninsular Malaysia and southern Thailand used for morphological examination (in black) and of specimens of at least two species groups in Peninsular Malaysia used for molecular analysis (in red on the map, with an asterisk here in the figure caption). The coast of Sumatra is omitted. 1 - Kaki Bukit (type locality of *L. yangae*); 2 - Thaleban N.P. (*L. yangae*; type locality of *L. thaleban* syn. nov.); 3 - Tone Nga Chang Waterfall (*L. yangae*); 4 - Sankalakhierie Mountains (*L. yangae*); 5 - Than To Waterfall (*L. yangae*; type locality of *L. rufipes* syn. nov.); 6 - Bukit Baring (*L. yangae*, reported under *L. rufipes* syn. nov.); 7 - Gunung Stong (*L. yangae*); 8 - Hala-Bala W.S. (*Liphistius* cf. *yangae*); 9 - Had Yai (*Liphistius* cf. *yangae*); 10 - Langkawi Island (type locality of *L. langkawi*); 11 - Penang Island, including Telok Bahang and Penang Botanic Gardens (type locality of *L. desultor* and of *L. murphyorum*); 12 - Gunung Jerai (= Kedah Peak) (*L. desultor*); 13 - foot of Maxwell Hill (*L. desultor*); 14 - Ulu Kinta and undisclosed locality near Ipoh (*Liphistius* cf. *desultor*); 15 - high altitudes of Maxwell Hill (type locality of *L. laruticus*); 16 - Gua Kanthan (type locality of *L. kanthan*); 17 - Gua Tempurung (type locality of *L. tempurung*; *L. kanthan*); 18 - Pangkor Island (type locality of *L. buran* sp. nov.); 19* Parit Falls (*Liphistius* sp.); 20*- Lake Kenyir (*Liphistius* sp.); 21* - Pasir Raja (*Liphistius* sp.); 22* - Felda Tekam (*Liphistius* sp.); 23* - Fraser's Hill (*L. malayanus*); 24* - Genting Highland (*L. malayanus*); 25* - Ulu Gombak Forest Reserve (*L. malayanus*); 26* - Kemensah Waterfall (*L. malayanus*); 27* - Ampang Forest Reserve (*L. malayanus*); 28* - Ulu Bendul Amenity Forest (*L. malayanus*); 29* - Endau-Rompin National Park (type locality of *L. endau*); 30* - Kota Tinggi Waterfall (*L. endau*).

Key to the species of the *trang*-group in Malaysia:

1 Large spiders [carapace lengths in males (largest female in parentheses) 8.4-12.9 (15.6), carapace width 7.4-11.4 (13.9)]; parts of carapace and proximal articles of legs and palps in females and large immature males[1] orange-coloured (Fig. 1A). Uniformly dark-coloured adult males of carapace length 8.4-8.5 and carapace width 7.4-8.0 with widely rounded or widely triangular para-embolic plate 2

\- Small to medium-sized spiders [carapace lengths in males (largest female in parentheses) 4.0-8.5 (8.1), carapace width 3.6-8.0 (7.4)]; body colouration of adult spiders light brown (Fig. 1B) or dark brown, limb articles uniformly dark or brown with more or less distinct dark annulations. Uniformly dark-coloured adult males of carapace length 8.4-8.5 and carapace width 7.4-8.0 (at present only applying to *L. laruticus*) with narrowly arched (subtegular apophysis present) or obliquely truncate (subtegular apophysis absent) para-embolic plate..... 3

2 Male palp always with basally wide tibial apophysis, deep paracymbium, longer than wide cumulus, medium-long proventral process of contrategulum, without ledge on prolateral side of contrategulum, and with narrowly arched, narrowly truncate or triangular para-embolic plate (Fig. 3); females with posterior stalk of vulval plate narrower than poreplate, in some (mostly young) specimens with light longitudinal median band, receptacular cluster as wide as long or only slightly longer, CDO situated in centre of poreplate (Fig. 4) ..... *L. yangae*

\- Male palp mostly with basally narrow tibial apophysis, with shallow paracymbium, wider than long cumulus, short proventral process of contrategulum, with distinct ledge on prolateral side of contrategulum, and with widely arched para-embolic plate (Fig. 5); females with posterior stalk clearly wider than poreplate, never with light median band, receptacular cluster distinctly longer than wide, CDO situated slightly posterior to centre of poreplate (Fig. 6) ..... *L. desultor*

3 Medium-sized spiders [carapace lengths in males (largest female in parentheses) 7.8-8.5 (8.1), carapace width 6.8-8.0 (7.4)]; body of adult spiders of both sexes uniformly dark-coloured; males with large, wide, obliquely truncate para-embolic plate, its proventral-distal corner protruding further than its retroventral-distal corner (Fig. 7A, E); females with rounded poreplate (Fig. 7J) ..... *L. laruticus*

\- Small spiders [carapace lengths in males (largest female in parentheses) 4.0-7.5 (7.8), carapace width 3.6-7.2 (7.1)]; body of adult spiders of both sexes brown, with more or less distinctly annulated limbs; males with para-embolic plate narrow (Figs 8B-D) or obliquely truncate, its retroventral-distal corner protruding further than its proventral-distal corner (Figs 10G, H, I); adult females with quadrangular poreplate 4

4 Palpal organ with distinct subtegular apophysis (Figs 8A-D, 9A, C, E, F); tegulum well developed; scopula on tarsi of anterior legs of males indistinct and not clearly delimited; poreplates with paired or unpaired processes on anterior margin (Figs 8E-I, 9H) 5

\- Palpal organ without subtegular apophysis; tegulum reduced (Figs 10J-K, 13E); scopula on tarsi of anterior legs of males distinct and quite clearly delimited; poreplates without processes on anterior margin (Figs 11, 15) 6

5 Males with normal paracymbium and with moderately long (less than twice as long as wide) subtegular apophysis, its apex widely rounded; para-embolic plate undivided, subtriangular; retrolateral edge of embolic base (not connected to para-embolic plate) elevated to form a distinct, subtriangular plate (Fig. 8A-D). Females with ventral rim of poreplate carrying four (two anterior and two anterolateral) processes (Fig. 8E-I). Both sexes without short setae anterior to fovea..... *L. murphyorum*

\- Males with voluminous, basally very wide paracymbium and with very long (three times longer than width at base) and tapering subtegular apophysis; para-embolic plate divided into narrow, spatulate proventral part and widely arched retroventral part; retrolateral edge of embolic base developed as an indistinct ledge (Fig. 9B, D, G). Females with ventral rim of poreplate carrying five (one anteromedian, two anterolateral and two posterolateral) processes (Fig. 9H). Both sexes with numerous short setae anterior to fovea ..... *L. langkawi*

6 Males with proximal-retrolateral heel of paracymbium carrying two enlarged spinules; proventral process of contrategulum indistinct; membrane at base of embolus complex without microtrichia; major embolic fold (see Schwendinger, 2017: fig. 3) narrow, normally developed (Fig. 10E-F, K). Females with poreplate possessing a well-developed posterior stalk (Fig 11). Both sexes without a pair of dark paramedian bands anterior to fovea .... *L. kanthan*

\- Males with heel of paracymbium carrying only one enlarged spinule; proventral process of contrategulum pronounced; membrane at base of embolus complex densely covered with microtrichia (Fig. 14A-E); major embolic fold basally wide, urn-shaped (Fig. 13E-F, H-I). Poreplate without posterior stalk (Fig. 15). Both sexes with a pair of dark paramedian bands anterior to fovea (Fig. 12A-B) ..... *L. buran* sp. nov.

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1 Small juveniles of all *Liphistius* species look the same and are indistinguishable on the basis of morphological characters.

(last moulted 16.VII.2011); Sankhalakhierie Mountains; 12.VII.2011; leg. P.J. Schwendinger. – MHNG, sample THMA-00/13a; 2 males (matured 10.VIII.2001 and 29.VIII.2002, respectively), 1 juv. male, 1 penultimate male, 7 females (last moulted 20.II.2001, 8.III.2002, 9.III.2001, 10.III.2001, 14.III.2001, 6.IV.2002, VII.2002, respectively); Malaysia, Perlis, Wan Tangga Valley (behind Gua Kelam), about 1 km W of Kaki Bukit village, 6°38'48"N, 100°11'51"E, 70 m; 8.VIII.2000; leg. P.J. Schwendinger. – MHNG, sample MAL-04/11; 1 male (matured 22.I.2007), 3 females (last moulted 12.I.2006, 31.XII.2006 and 5.I.2007, respectively); Malaysia, Kelatan, Gunung Stong (= Setong), 5°20'22"N, 101°58'15"E, 200 m, rainforest near stream; 10.VI.2004; leg. P.J. Schwendinger.

Diagnosis: Large spiders. Females and immature males of at least one year of age with orange-coloured femora and carapace. Distinguished from *L. bicoloripes* Ono, 1988 (occurring north of the range of *L. yangae*) by dark tibiae and patellae (orange-coloured in *L. bicoloripes*) in females and immature males. Females different by genital atrium with fewer or no lateral hairs, and poreplate posteriorly equally wide or wider than anteriorly (equally wide or narrower in *L. bicoloripes*) (Fig. 4; Schwendinger, 1995: figs 9-11 cf. Schwendinger, 1995: figs 38-41). Males different by a narrowly rounded or triangular, scale-like paraembolic plate (obliquely truncate in *L. bicoloripes*), by a shorter proventral process on contrategulum, by a tegulum with a pronounced distal edge and a sigmoid row of teeth on proximal edge (distal tegular edge indistinct and proximal edge with curved row of teeth in *L. bicoloripes*) and by a longer paracymbium with a slightly more elevated cumulus (Fig. 3; Schwendinger, 1995: figs 1-7 cf. Schwendinger, 1995: figs 32-37). Distinguished from *L. desultor* (occurring south of the range of *L. yangae*) by males with a longer, apically rounded proventral process on contrategulum (Fig. 3E-H cf. Fig. 5F-G), without an elevated ridge on prolateral side of contrategulum (Fig. 3E cf. Fig. 5F-G, I-K), with a narrower (longer than wide) and less distinctly elevated cumulus carrying weaker and more scattered bristles (Fig. 3C-D cf. Fig. 5A-B, D-E), and usually with a basally wider tibial apophysis (Fig. 3A-B cf. Fig. 5A-B; but see Fig. 5C and paragraph "Variation"). Females very difficult to distinguish from females of *L. desultor*: usually without or with only indistinct median processes on lateral margin of poreplate and with a not much longer than wide receptacular cluster (Fig. 4 cf. Fig. 6); some specimens with an arched distal margin of the poreplate and with very few or no median and lateral hairs in genital atrium (Fig. 4; Schwendinger, 1990: figs 53-56; Schwendinger, 1995: figs 9-11 cf. Fig. 6; Murphy & Platnick, 1981: figs 22-23; Platnick & Sedgwick, 1984: figs 50-51; Platnick *et al.*, 1997: fig. 28; Haupt, 2003: fig. 43A-B).

Additions to description of male: Scopula weak on tarsi I-II, denser on tarsi III-IV; only distally divided by median stripe on all leg tarsi; covering distal third of ventral side of tarsus I, distal half of tarsus II, distal two-thirds to three-fourths of tarsus III and distal two-thirds to four-fifths (in largest male, the *L. rufipes* syn. nov. paratype from Bukit Baring) of tarsus IV.

Variation: Carapace length in males (n=9) ranges 8.36-12.88, carapace width 7.42-11.43. The largest female (from Than To Waterfall; a paratype of *L. rufipes* syn. nov.) has a 15.61 long and 13.91 wide carapace. In the four obviously juvenile female paratypes examined the carapace length is 5.20-5.79, the carapace width 4.37-4.92; in the female holotype (not examined; probably also not fully grown) it is 6.41 and 5.53, respectively (Platnick & Sedgwick, 1984: 14). The number of short setae anterior to the fovea ranges from zero to six.
The shape of the vulva is very variable (Fig. 4) and consequently a clear distinction between females of *L. yangae* and *L. desultor* is not always possible. Variation in characters of the male palp is shown in Fig. 3.

Remarks: The type series of *L. yangae* consists of quite small, juvenile females, as shown by the incompletely developed and weakly sclerotised vulval plates with a relatively large but not clearly outlined CDO, by a low, indistinct receptacular cluster and by an indistinctly outlined, lightly pigmented/sclerotised posterior stalk (Fig. 4A-C). None of the new female specimens examined has a poreplate as illustrated in Platnick & Sedgwick (1984: figs 22-23; presumably the holotype, but not identified as such; anteriorly distinctly narrower than posteriorly, anterior margin straight, lateral processes on ventral rim absent). However, the smallest vulval plates of non-type females examined (from an exuvia of a specimen from the Sankalakhierie Mts and from Gunung Stong), although about double the size of the largest *L. yangae* paratype examined, are quite similar (Fig. 4D-E). These differences are probably due to different body sizes and interspecific variation (see paragraph "Variation"). A relatively large CDO appears to be a juvenile character state in females of this species (as perhaps in others). This character state seems to be retained in fully-grown females of the *malayanus*-, *timan*- and *batuensis*-groups (see Schwendinger, 2017) but not in other species groups. A relatively large CDO may be plesiomorphic.
Another reason for placing *L. thaleban* syn. nov. in the synonymy of *L. yangae* is the fact that adult male and female spiders collected at Kaki Bukit (the type locality of *L. yangae*) are very similar to and obviously conspecific with the types of *L. thaleban* syn. nov. (its holotype is an exceptionally small male). The type localities of both nominal species are only about 6 km apart (see Fig. 2, localities 1 and 2). Since the female holotype of *L. yangae* obviously has bicoloured legs (femora given as yellow

in the original description of 1984, probably orange-coloured when the specimen was collected in 1938), as have females of *L. thaleban* syn. nov. and *L. rufipes* syn. nov. which occur in the same area, it is very likely that these three names in fact refer to one single species. Other large *Liphistius* species with orange-coloured leg articles (*L. bicoloripes, L. dangrek* Schwendinger, 1996, *L. desultor, L. isan* Schwendinger, 1998, *L. ornatus* Ono & Schwendinger, 1990, *L. sumatranus* Thorell, 1890) have relatively large geographical ranges. This also appears to be the case in *L. yangae*.

Relationships: *Liphistius yangae* belongs to species complex D (see Schwendinger, 1998: 29, table 2) due to the following combination of characters: cumulus plane

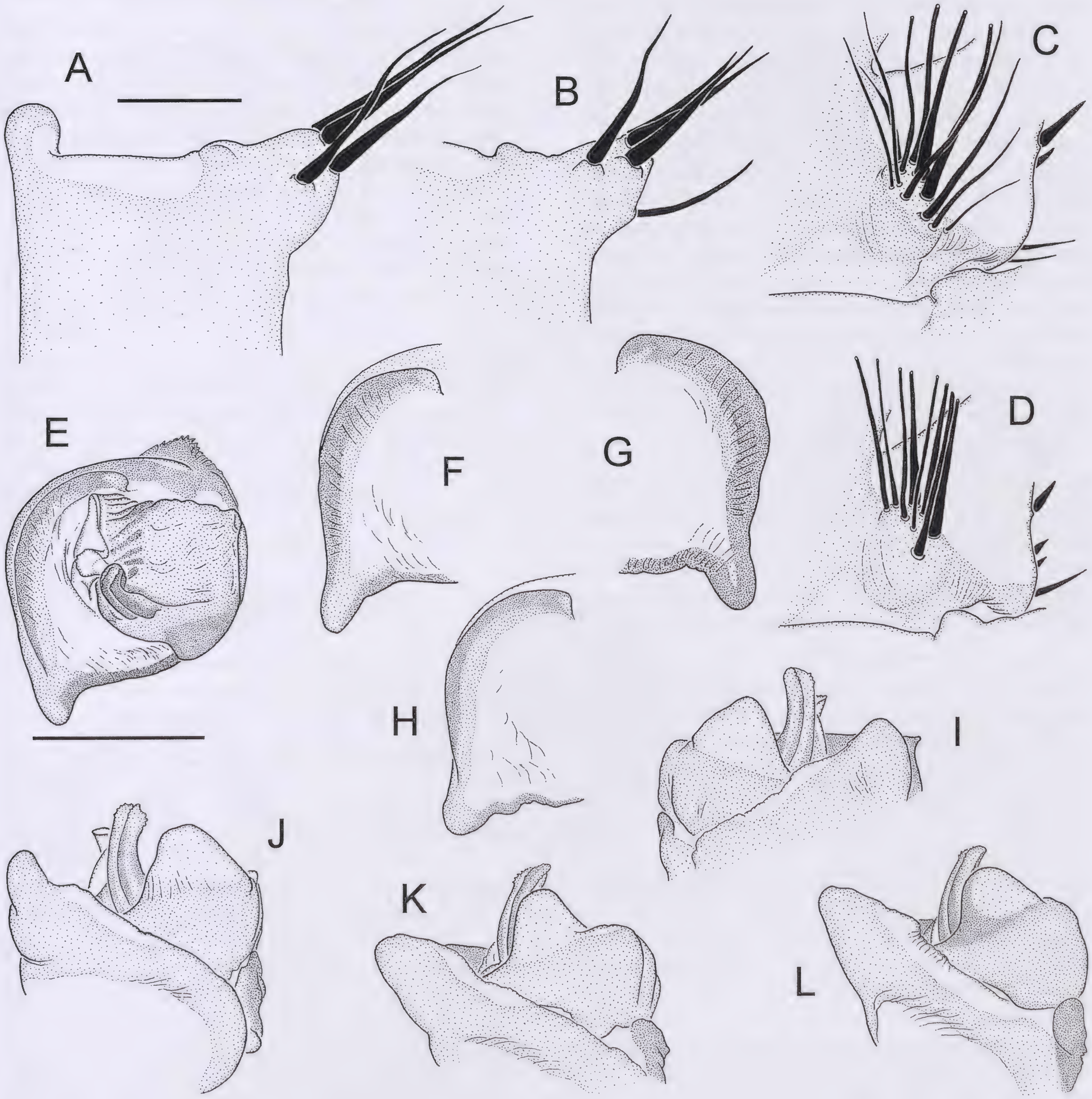


Fig. 3. *Liphistius yangae*, details of six males: from Kaki Bukit, matured 29.VIII.2002 (A, C, K), from Kaki Bukit, matured 10.VIII.2001 (B, D-E, L), from Gunung Stong (F, J), from the Sankalakhierie Mts (H), from Bukit Baring (paratype of *L. rufipes* syn. nov.; G) and from Than To Waterfall (holotype of *L. rufipes* syn. nov.; I). (A) Distal part of left tibia, ventral view. (B) Tibial apophysis of left palp, ventral view. (C-D) Cumulus on left palp, ventral view. (E) Left palpal organ, distal view (dorsal side up). (F, H) Distal edge of contrategulum of left palp, distal view. (G) Same of right palp. (I) Distal part of right palpal organ, ventral view. (J) Same of left palp. (K-L) Same of left palp, retroventral view. Scale lines 1.0 mm (A-B; C-L).

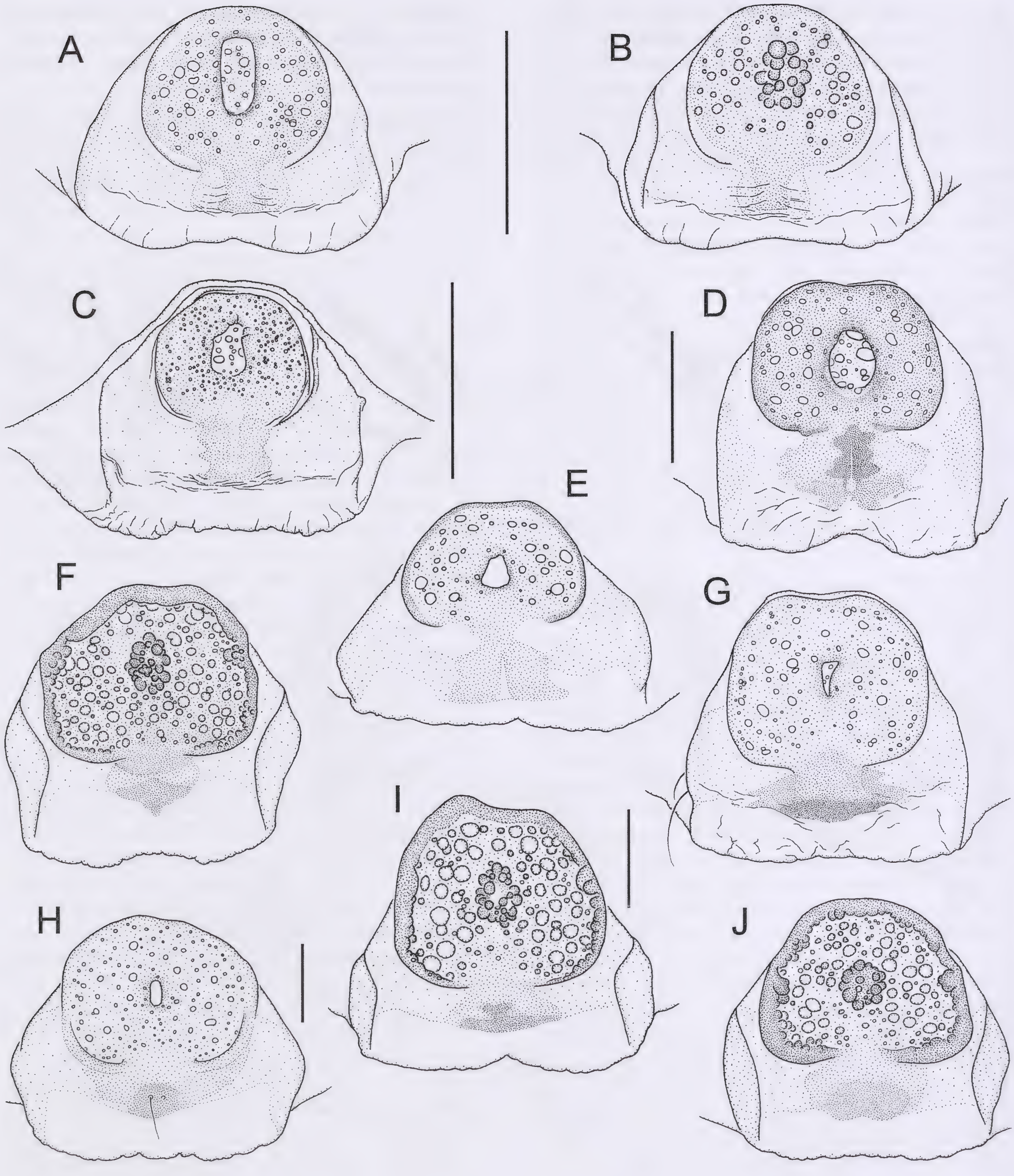


Fig. 4. *Liphistius yangae*, details of vulval plate of nine females; dorsal view (A, C-E, G-H), ventral view (B, F, I-J). (A-B) First juvenile paratype. (C) Second juvenile paratype. (D) Juvenile from Gunung Stong. (E) Juvenile from the Sangkalakhierie Mts. (F) Mature specimen (moulted 20.II.2001) from Kaki Bukit. (G) Different specimen from Kaki Bukit (moulted 17.VIII.2000). (H) Different specimen from Kaki Bukit (moulted 14.III.2001). (I) Different specimen from Kaki Bukit (moulted 9.III.2001). (J) Mature specimen (moulted 16.VII.2011) from the Sangkalakhierie Mts. Scale lines 0.5 mm (A-B; C; D-G; H, J; I).

or slightly elevated and bearing long stiff bristles, dark patch with spinules on paracymbium not isolated by a pale band, sclerotised part of embolus with 2-3 ridges running into pointed apex. Only in species complex D (in southern Thailand, western Malaysia and Sumatra) and in species complex A (in eastern Thailand; both probably more closely related to each other than to other species complexes) we have species with a large body and with an orange-coloured carapace and orange-coloured proximal leg and palp segments.

Distribution: *Liphistius yangae* appears to have a wide distribution on both sides of the border between Malaysia and Thailand. For three localities in northern Malaysia and four from southern Thailand mature males are available, and these records are therefore quite reliable. Additional spiders, which presumably also belong to this species, were seen (but not collected) in Thailand: inside the campus of the Prince of Songkhla University in Had Yai (Songkhla Province) and near the Sirinthon (= Sirindhorn) Waterfall in the Hala-Bala Wildlife Sanctuary (Narathiwat Province). See Fig. 2, localities 1-9.

Biology: Males in captivity became mature in July, August, December, January and February. Females usually moulted twice per year. Further information on the biology of this species is given in Schwendinger (1990: 347, under *L. thaleban* syn. nov.) and in Schwendinger (1995: 144-145, under *L. rufipes* syn. nov.).

Liphistius desultor Schiödte, 1849

Figs 1A, 5-6

Liphistius desultor Schiödte, 1849: 621-623, pl. 5, figs 1-7 (description of female). – Kraus, 1978: 237-239, figs 2-4 (first illustration of male palp under *L. batuensis* Abraham, 1923a).

For synonyms and further relevant taxonomic literature, see World Spider Catalog (2019).

Type material: ZMC; female holotype (not examined); "Pinang insula"; van Teylingen.

Material examined: MHNG; 1 male (matured 23.VIII.1992); Penang Hill (= Bukit Bendera), 700 m; 1.XII.1991; leg. P.J. Schwendinger. – SMF (no inventory number; ex coll. O. Kraus); 1 male without palps; Penang Island; 1.X.1961; leg. H. Klingel. – SMF (no inventory number; ex coll. O. Kraus); right palp (metal-coated for SEM), probably belonging to male without palps. – BMNH 1975.1.24.4 (ex. coll. W.S. Bristowe); 2 females (1 large, 1 small), 3 juv. males (2 of them penultimate); Penang; 6.XI.1974; leg. W.S. Bristowe. – BMNH (no inventory number; ex. coll. W.S. Bristowe); 1 female; Kedah Peak; I.1932; leg. W.S. Bristowe. – MHNG; 1 male (matured 26.X.1995); Gunung Jerai (= Kedah Peak), 170 m; 1.II.1995; leg. P.J. Schwendinger. – MHNG; 1 male (matured 10.X.1996); Bukit Larut (= Maxwell Hill), 50 m; 8.I.1996; leg. P.J. Schwendinger.

Diagnosis: Large species, adult females and large juveniles of both sexes with orange-coloured femora on legs and palps (Fig. 1A). Similar to *L. yangae*, males distinguished by basally narrower tibial apophysis (Fig. 5A-B cf. Fig. 3A-B, but see Fig. 5C and paragraph "Variation"), by shallower paracymbium, by wider than long cumulus with bristles arranged in one row (Fig. 5A-B, D-E cf. Fig. 3C-D), by basally wide and almost symmetrical proventral process of contrategulum (Fig. 5F-G cf. Fig. 3E-H), by prolateral side of contrategulum with a pronounced ledge (the most obvious distinction; Fig. 5F-G, I-K, see arrows), by proximal edge of tegulum with stronger teeth, and by more widely rounded para-embolic plate (Fig. 5H, K cf. Fig. 3I-L). Females difficult to distinguish from those of *L. yangae*; quadrangular poreplate generally with only very slightly arched to slightly invaginated anterior margin and thick lateral margins carrying indistinct anterolateral processes; receptacular cluster quite long and bent anteriad (Fig. 6C), distinctly longer than wide in ventral view (Fig. 6A, D cf. Fig. 4F, I-J); CDO in a slightly more posterior position (behind centre of poreplate; Fig. 6B, E cf. Fig. 4G-H for adult specimens); posterior stalk short, wider than poreplate (Fig. 6A-B, D-E cf. Fig. 4).

Additions to description of male: Scopula weak on tarsi I-II, denser on tarsi III-IV, only distally divided by median stripe on all leg tarsi; covering distal third of ventral side of tarsus I, distal half or slightly less of tarsus II, three-fifths to two-thirds (only in male from Gunung Jerai) of tarsus III, and distal two-thirds of tarsus IV.

Variation: Carapace length in males (n=5), including the one described in Platnick & Sedgwick, 1984: 20), is 9.49-11.16, carapace width 8.05-9.94; in the largest female (described in Platnick & Sedgwick, 1984: 18-20) it is 14.62 and 12.46, respectively. Variation in details of the male palp are given in Fig. 5; variation in the vulval plate of two females in Fig. 6. Most males examined and a male illustrated in the literature have a basally narrow tibial apophysis (Fig. 5A-B; Platnick & Sedgwick, 1984: fig. 47). However, the male from Gunung Jerai (Fig. 5C) has a basally wide tibial apophysis on both palps, as is the case in *L. yangae* males, but otherwise corresponds to *L. desultor*, especially in possessing a distinct (but slightly smaller than in other conspecific males) ledge on the prolateral surface of the contrategulum (Fig. 5K). Only two of the females examined or illustrated in the literature have a single hair on one of the lateral folds of the genital atrium (Fig. 6D; Platnick *et al.*, 1997: fig. 28), all other females are without hairs inside the vulva (Fig. 6A; Murphy & Platnick, 1981: fig. 23; Platnick & Sedgwick, 1984: fig. 51).

Relationships: *Liphistius desultor* appears to be most closely related to *L. yangae*. Both belong to species complex D.

Distribution: *Liphistius desultor* is known from several lowland and upland localities on Penang Island, and from low altitudes on the nearby mainland: Kedah Peak (= Gunung Jerai) and Maxwell's Hill (= Bukit Larut). The species probably also occurs at an undisclosed locality near Ipoh (unconfirmed record documented in photos by Kenneth Fletcher, see Fig. 1A) and, according to molecular data, also at Ulu Kinta near Ipoh. See Fig. 2, localities 11-14.

Biology: The spiders examined were collected from sides of roads and trails inside and close to rainforests. They were locally quite abundant on Penang Hill, but much less so on Gunung Jerai and at the foot of Maxwell's Hill. In captivity two males became mature in late August and late October. A mature male was collected on Penang Hill in late July (Platnick & Sedgwick, 1984: 20). An egg case containing 509 eggs was found on Penang Hill at the beginning of December (Platnick *et al.*, 1997: 12). Further information on the biology of this species (and its burrow structure) is found in Yong (1978), Murphy & Platnick (1981) and Platnick *et al.* (1997).

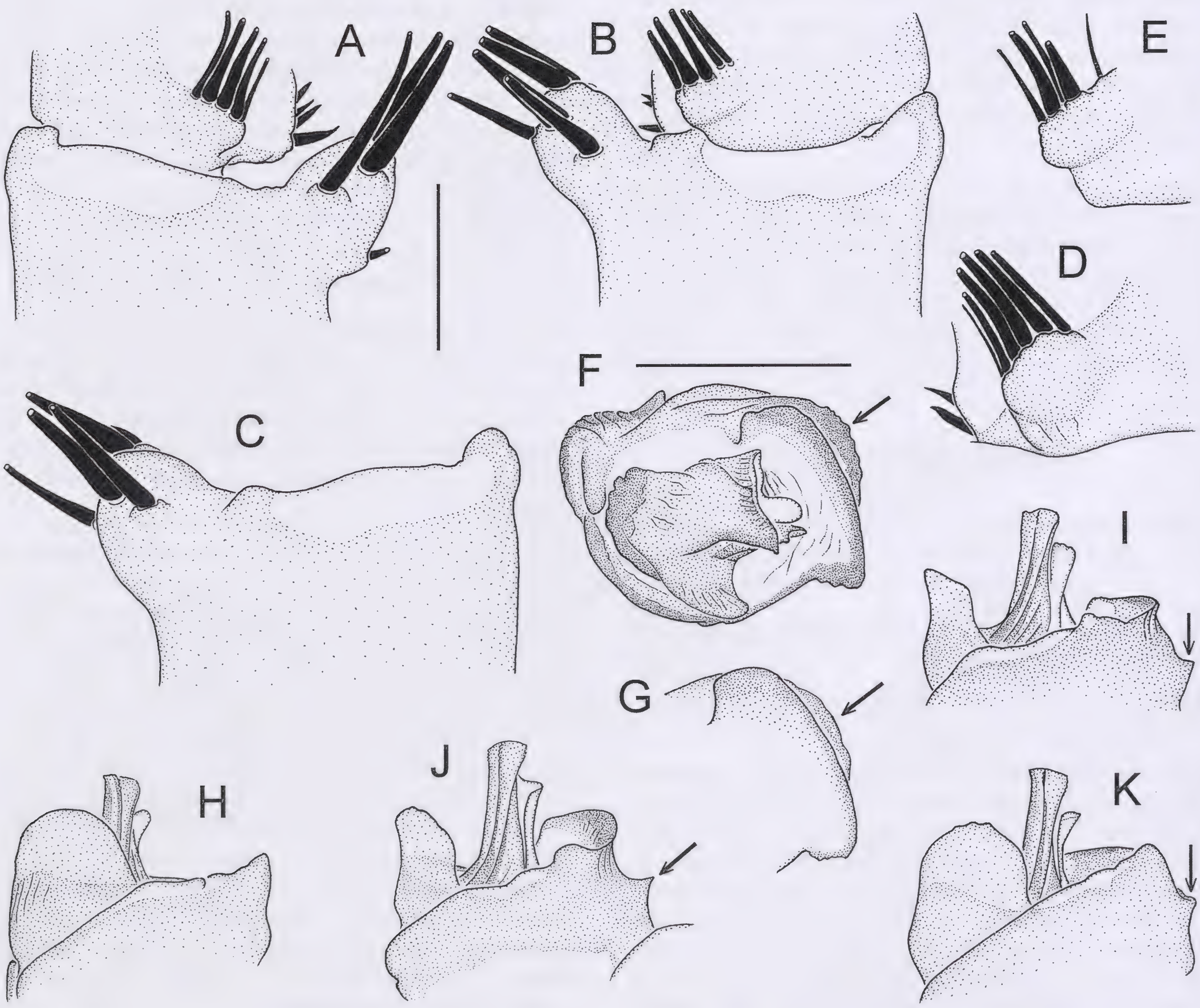


Fig. 5. *Liphistius desultor*, details of palp of four males: from Penang Hill (in MHNG; A, H-I), from Penang Island (in SMF; E, G), from Maxwell Hill (B, F, J), from Gunung Jerai (= Kedah Peak) (C-D, K). (A) Distal part of tibia and base of left tarsus, ventral view. (B-C) Same of right palp. (D-E) Cumulus of right palp, ventral view. (F) Palpal organ, distal view; arrow indicating ledge on prolateral side of contrategulum. (G) Distal edge and prolateral ledge (indicated by arrow) of contrategulum, distal view. (H, K) Distal part of right palpal organ, retroventral view. (I-J) Same, ventral view; arrow indicating ledge on prolateral side of contrategulum (also in K). Scale lines 1.0 mm (A-C; D-K).

Liphistius laruticus Schwendinger, in Platnick, Schwendinger & Steiner, 1997

Fig. 7

Liphistius laruticus Schwendinger, in Platnick, Schwendinger & Steiner, 1997: 9-11, figs 14-21 (description of male and female).

Types: MHNG; male holotype (matured 3.VIII.1995), male paratype (matured 30.VIII.1994) and 2 female paratypes (all examined); Malaysia, Maxwell Hill, 1380 m, 4°51'31"N, 100°48'07"E; 20.I.1994; leg. P.J. Schwendinger.

Other material examined: MHNG; 1 male (matured 28.VII.2002); Maxwell Hill (4°51.694'N, 100°47.631'E), 1000-1300 m; 24.IX.2001; leg. L. Monod.

Diagnosis: Similar and probably closely related to *L. desultor*, distinguished by uniformly dark colour in females and large juvenile males. Males different by a basally wider tibial apophysis, by the lack of a prominent ledge on prolateral side of contrategulum, by a narrower dorsal apex of the distal contrategular edge (Fig. 7F-H cf. Fig. 5F-G), and by a quadrangular, widely and obliquely truncate para-embolic plate with its proventral-distal corner more protruding than its retroventral-distal corner (the most obvious distinction; Fig. 7A, E cf. Fig. 5H, K). Females with poreplate rounded rather than rectangular, with arching anterior margin (Fig. 7I-J; Platnick *et al.*, 1997: figs 20-21 cf. Fig. 6). Scopula on tarsus IV of males distinctly thinner and shorter than in *L. desultor*.

Additions to description of male: Scopula thin on tarsi I and IV, slightly denser on tarsi II and III; only distally divided by median stripe on all leg tarsi; covering distal third of ventral side of tarsus I, distal two-fifths of tarsus II, distal half of tarsus III and distal two-fifths

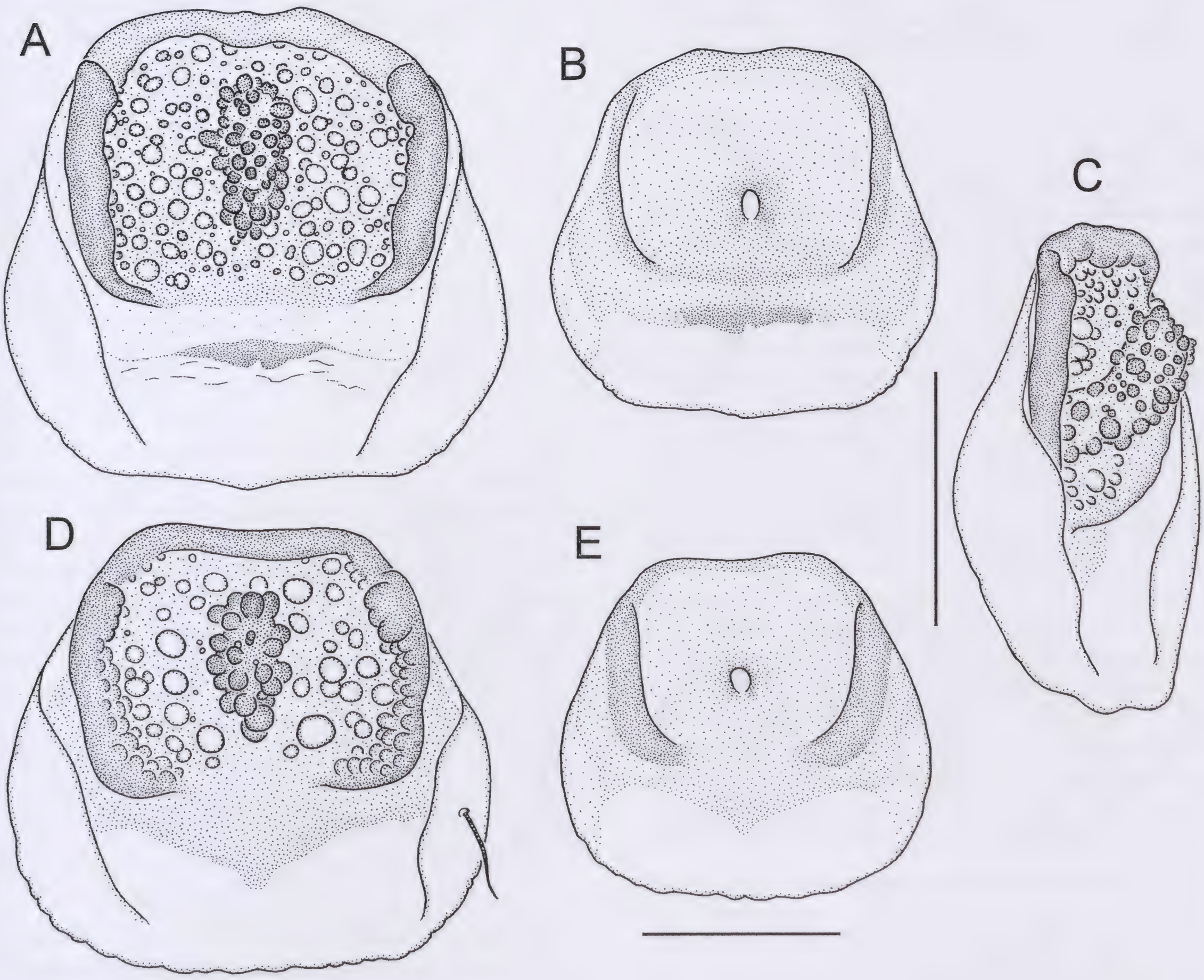


Fig. 6. *Liphistius desultor*, vulval plate of female (BMNH 175.1.24.4) from Penang Island (A-C) and of female (BMNH) from Gunung Jerai (= Kedah Peak) (D-E). (A, D) Ventral view. (B, E) Dorsal view, pores not illustrated. (C) Lateral view showing shape of receptacular cluster. Scale lines 1.0 mm (A, C-D; B, E).

of tarsus IV. Obliquely truncate para-embolic plate with its proventral-distal corner more protruding than its retroventral-distal corner (Fig. 7A, E).

Variation: Carapace length in males (n=3) is 7.84-8.53, carapace width 6.81-7.99; in the largest female (the allotype) it is 8.14 and 7.35, respectively.

Distribution: *Liphistius laruticus* is only known from altitudes above 1000 m on Maxwell Hill (= Bukit Larut). See Fig. 2, locality 15. *Liphistius desultor* occurs at the foot of the same mountain (Fig. 2, locality 13). Considering that both species are probably closely related, we assume that they are separated by different microclimatic conditions at different altitudes of Maxwell Hill, which receives the highest rainfall in Peninsular Malaysia.

Relationships: *Liphistius laruticus* appears to be more closely related to *L. desultor* than to *L. yangae*. All three belong to species complex D.

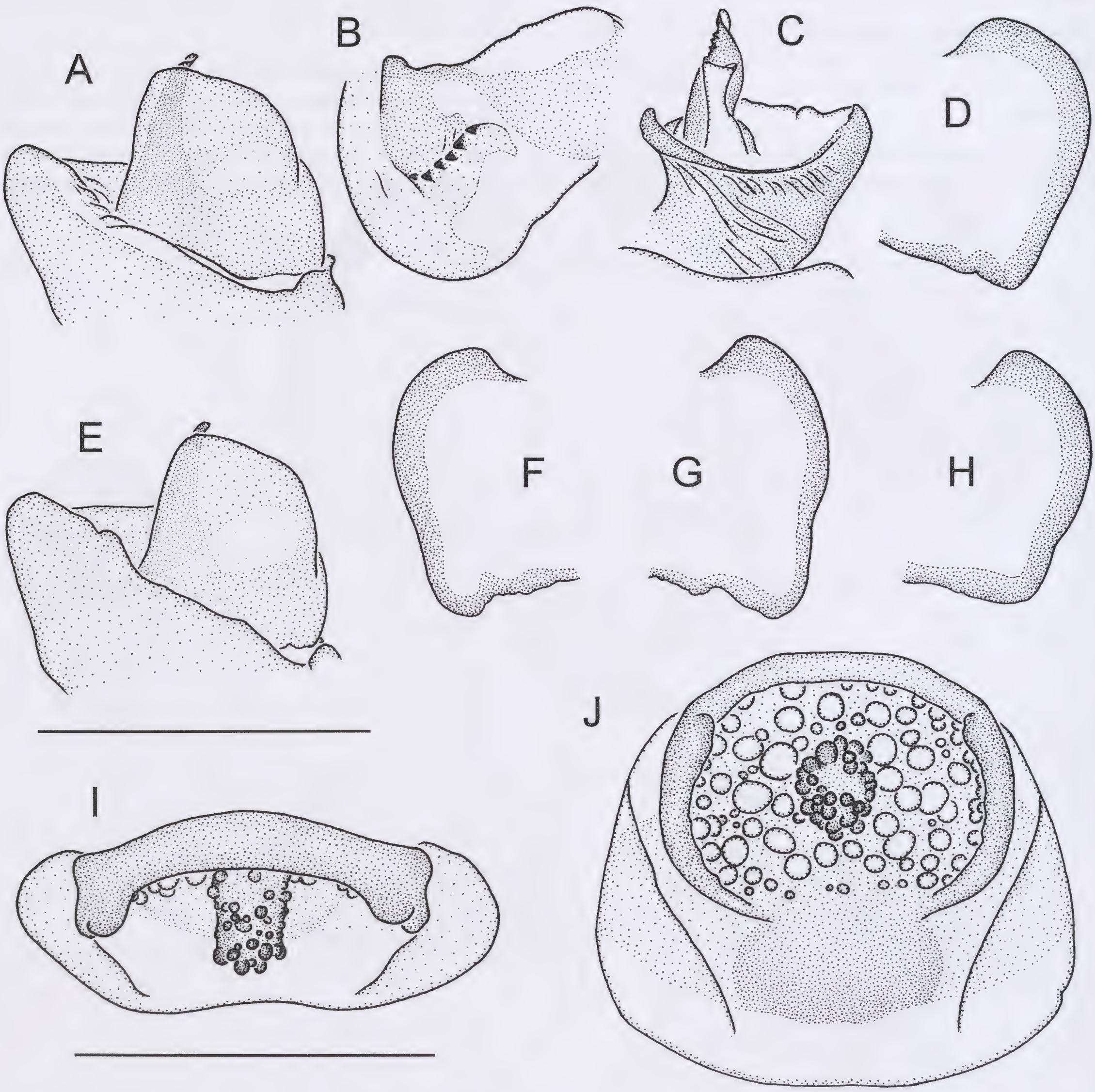


Fig. 7. *Liphistius laruticus*, details of male (A-H) and female genitalia (I-J); male holotype (A-D), new male (matured 28.VII.2002) (E-G), male paratype (H), female allotype (I-J). (A, E) Distal part of left palpal organ, retroventral view. (B) Left tegulum, retrolateral view. (C) Distal part of left palpal organ, prodorsal view. (D, G-H) Distal edge and proventral process of contrategulum of right palp, distal view. (F) Same of left palp. (I) Vulval plate (of exuvia), anterior and slightly ventral view. (J) Same, ventral view. Scale lines 1.0 mm (A-H; I-J).

Liphistius murphyorum Platnick & Sedgwick, 1984

Fig. 8

Liphistius desultor Schiödte, 1849. – Murphy & Platnick, 1981: 51-55, figs 7, 10, 13, 16, 19 (misidentification of male).

Liphistius n. sp. A. – Haupt, 1983: 279, fig. 3a (description of male without giving an available species name).

Liphistius murphyorum Platnick & Sedgwick, 1984: 16-18, figs 16, 38-44 (description of male and female, provision of available species name). – Haupt, 2003: 71, figs 44C, 46A-B (photo of male and SEM of male palp). – Schwendinger, 2009: 1262-1263, figs 20-21 (illustration of palpal organ).

Types: AMNH; male holotype and female paratype (not examined); Malaysia, Penang Island; 20.VII.1982; leg. W.C. Sedgwick.

Material examined: MHNG; 1 male (matured X.1985); Malaysia; Penang Island, Penang Hill, about 700 m; XII.1984; leg. P.J. Schwendinger. – SMF (ex coll. O. Kraus); 1 male, 2 females; Penang Island; 1.X.1961; leg. H. Klingel. – MHNG (ex coll. O. Kraus; received in exchange from SMF); 1 male; Penang Island; 1.X.1961; leg. H. Klingel. – SMF; 1 male, 1 female; Penang Island; 1.X.1961; leg. H. Klingel. – SMF; 3 females, 3 juveniles; Penang Island; 30.IX. (no year given, presumably 1961); leg. H. Klingel. – MHNG (received in exchange from SMF); 1 female; Penang Island; 30.IX. (no year given, presumably 1961); leg. H. Klingel. – SMF (ex coll. O. Kraus); 1 isolated male palp; no locality, date or collector given.

Diagnosis: Relatively small species, distinguished from all other *Liphistius* species by the combination of a long and strong subtegular apophysis with a domed apex, and a quite long, subtriangular (with narrowly rounded apex) para-embolic plate next to a more or less long (but always shorter than para-embolic plate), subtriangular plate (i.e. an extension of the retrolateral edge of the embolus complex) at a very narrow angle to the para-embolic plate in males (Fig. 8A-D; Platnick & Sedgwick, 1984: figs 38-42; Schwendinger, 2009: figs 20-21), and by four (two anterior and two anterolateral) protuberances on the ventral rim of the poreplate in females (Fig. 8E-F, H; Platnick & Sedgwick, 1984: fig. 44).

Additions to description: Scopula of males very thin, indistinct and not clearly delimited on tarsi I-II, dense and clearly delimited on tarsi III-IV; spread over distal four-fifths of ventral side and only distally divided by median stripe on all leg tarsi. No setae anterior to fovea in either sex.

Variation: Carapace length in males (n=5, including measurements of holotype given in Platnick & Sedgwick, 1984: 18) ranges 5.05-6.03, carapace width 4.25-5.43. In the largest female (out of four examined plus the female described by Platnick & Sedgwick, 1984: 16) it is 6.96 and 6.08, respectively.

Relationships: The pronounced subtegular apophysis of the palpal organ and the presence of processes on the anterior margin of the poreplate clearly show that *L. murphyorum* belongs to species complex E (Schwendinger, 2009: 1263, there incorrectly called "superspecies D"). *Liphistius langkawi* from Langkawi Island (Malaysia) and *L. thaleri* from Libong Island (Thailand), both off the west coast of the Thai-Malay Peninsula, also belong to this very distinct subgroup.

Distribution: *Liphistius murphyorum* is only known from Penang Island, having been collected at the foot and at higher altitudes of Penang Hill (Fig. 2, locality 11). On this mountain *L. murphyorum* occurs together with *L. desultor*, and the two species seemingly share the same habitat.

Liphistius langkawi Platnick & Sedgwick, 1984

Fig. 9

Liphistius langkawi Platnick & Sedgwick, 1984: 14-16, figs 31-37 (description of male and female). – Schwendinger, 2009: 1260-1262, figs 13-19 (illustration of palpal organs and vulvae).

Material examined: Same material (5 males and 12 females from Langkawi Island; leg. P.J. Schwendinger) as mentioned in Schwendinger (2009: 1260-1261). One male and one female from this lot now deposited in SMF (exchange of specimens). No new material available.

Diagnosis: Relatively small species. Males distinguished from those of all other *Liphistius* species by the unique combination of a voluminous, basally very wide paracymbium, an extremely long, tapering subtegular apophysis, a narrowly rounded dorsal contrategular apex with a trench-like depression flanking and sheltering the major embolic fold on one side (Fig. 9A, C, E, F, see arrows), a para-embolic plate divided into a very narrow, spatulate proventral part and a widely arched retroventral part, and a not or only slightly elevated ledge on retrolateral edge of embolus complex at a wide (about 60°) angle to the para-embolic plate (Fig. 9A-G; Platnick & Sedgwick, 1984: figs 31-35; Schwendinger, 2009: figs 13-15). Females distinguished by five (one anteromedian, two anterolateral and two posterolateral) protuberances on ventral rim of poreplate (Fig. 9H; Platnick & Sedgwick, 1984: figs 36-37; Schwendinger, 2009: figs 16-19).

Additions to description: Scopula on all legs very thin, indistinct and not clearly delimited, composed of hairs scattered over distal four-fifths of ventral side of tarsi, decreasing in density from distal to proximal. Both sexes with numerous short setae anterior to fovea.

Variation: Carapace length in males (n=6, including measurements of the holotype given in Platnick &

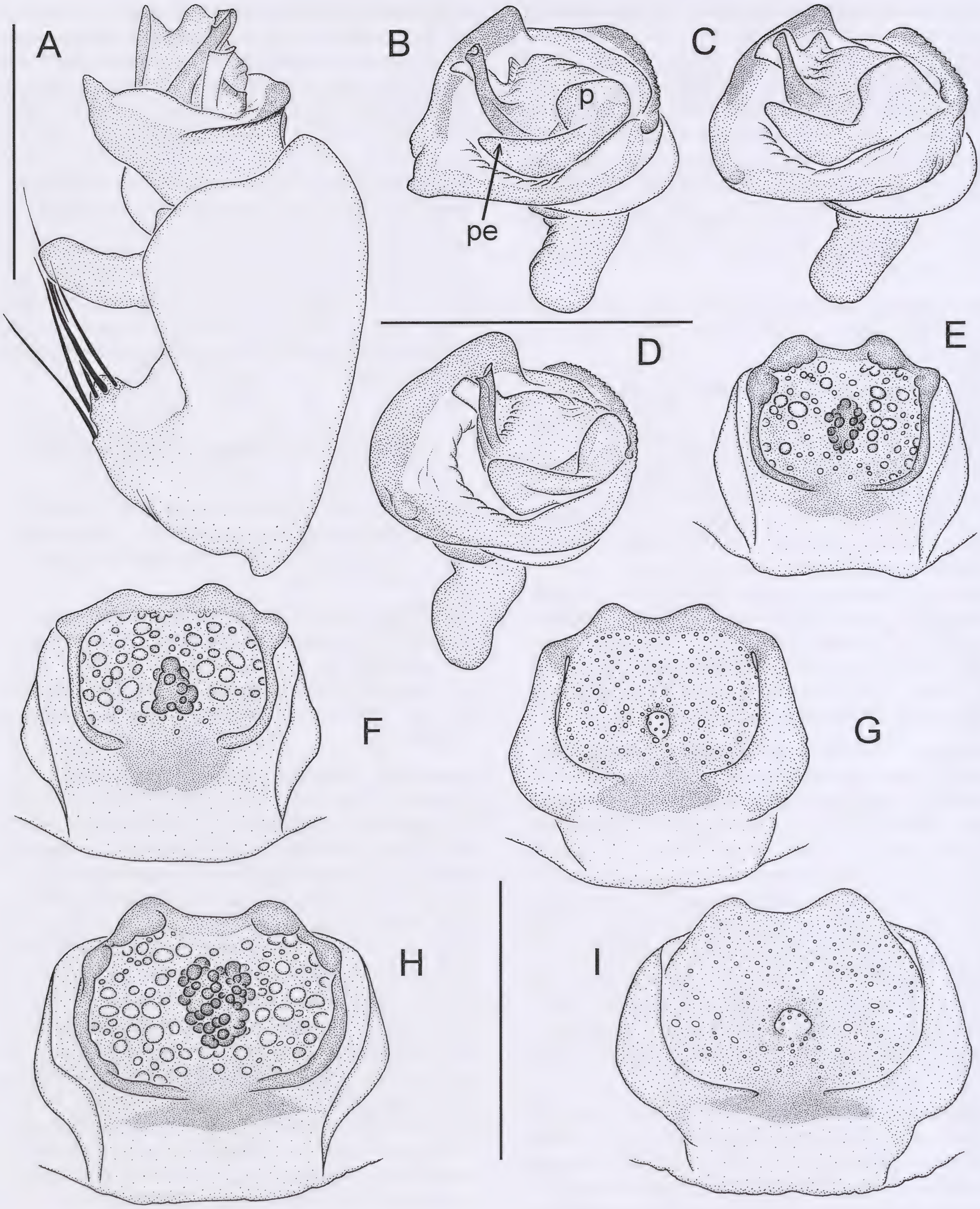


Fig. 8. *Liphistius murphyorum*, details of right palp of four males (A-D; A in MHNG, B-D in SMF) and vulval plate of three females (E-I; E in MHNG, F-I in SMF). (A) Tarsus and palpal organ, prolateral view. (B-D) Palpal organ, distal view (dorsal side up). (E-F, H) Vulval plate, ventral view. (G, I) Same, dorsal view. Abbreviations: pe = para-embolic plate; p = plate on retrolateral edge of embolus complex. Scale lines 1.0 mm (A; B-D; E-I).

Sedgwick, 1984: 16) ranges 4.02-5.69, carapace width 3.47-5.29; in the largest female (out of twelve examined) it is 7.21 and 6.27, respectively. Variation in the shape of the vulva is illustrated for the paratype in Platnick & Sedgwick (1984: figs 36-37) and for four non-type females in Schwendinger (2009: figs 16-19). The palpal organ of the holotype and of two non-type males is illustrated in Platnick & Sedgwick (1984: 31-35) and Schwendinger (2009: figs 13-15), respectively. Figure 9A-G shows the shape of the subtegular apophysis and of the structures on the ventral to retroventral edge of the embolus complex of another four non-type males; Fig. 9H shows the vulval plate of an additional non-type female. Five to ten short setae are present anterior to the fovea in both sexes. These are more or less clearly continuous with numerous short setae behind the eye tubercle. The AME in two males and three females are reduced or completely absent on one side.

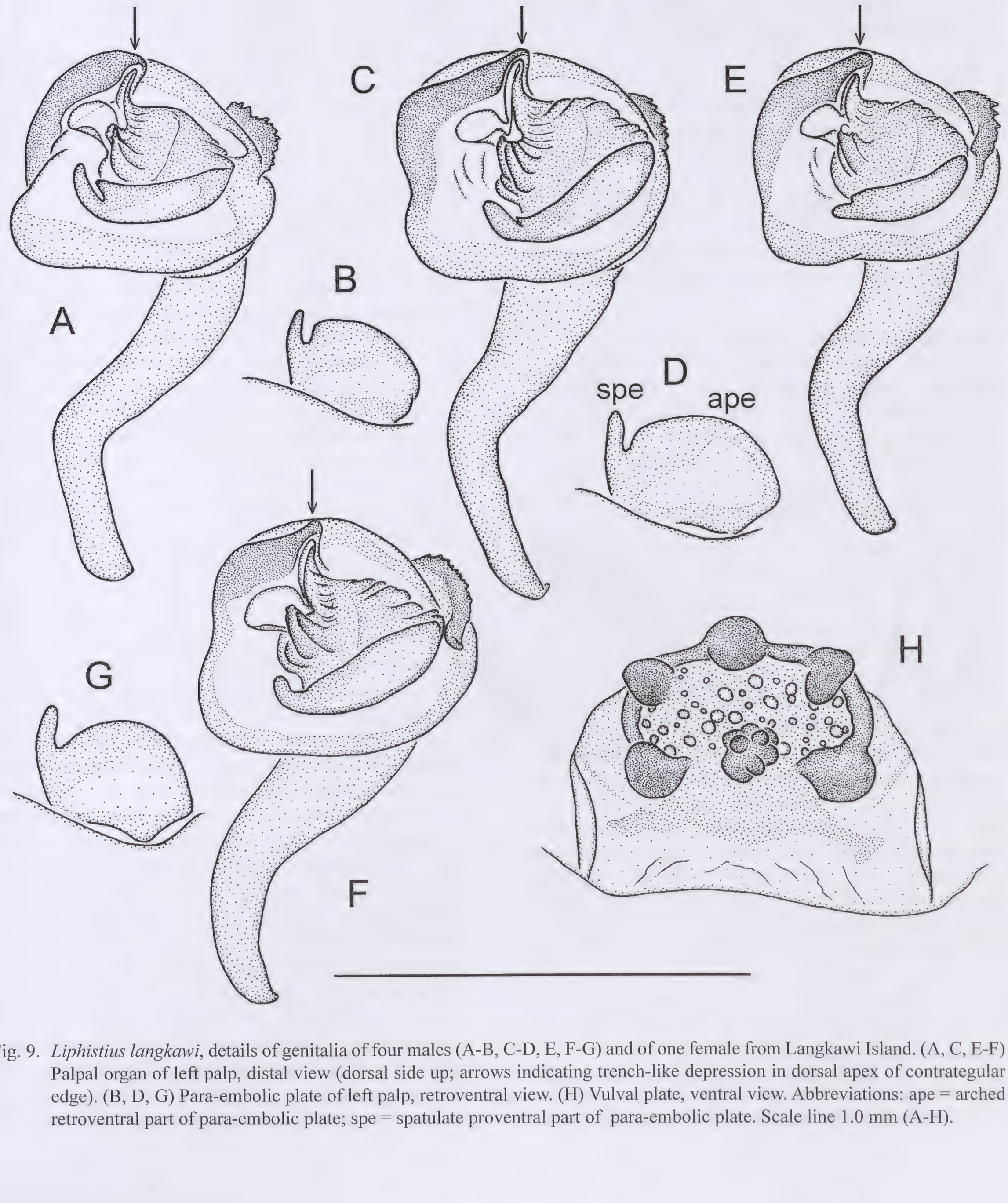


Fig. 9. *Liphistius langkawi*, details of genitalia of four males (A-B, C-D, E, F-G) and of one female from Langkawi Island. (A, C, E-F) Palpal organ of left palp, distal view (dorsal side up; arrows indicating trench-like depression in dorsal apex of contrategular edge). (B, D, G) Para-embolic plate of left palp, retroventral view. (H) Vulval plate, ventral view. Abbreviations: ape = arched retroventral part of para-embolic plate; spe = spatulate proventral part of para-embolic plate. Scale line 1.0 mm (A-H).

Relationships: The extremely long subtegular apophysis of the male palp and the distinct anterior and anterolateral protuberances on the ventral rim of the poreplate clearly show that *L. langkawi* belongs to species complex E, together with *Liphistius murphyorum* and *L. thaleri*.

Biology: See Platnick & Sedgwick (1984: 16) and Schwendinger (2009: 1261-1262).

Distribution: *Liphistius langkawi* is only known from two localities on Pulau Langkawi. Since these localities are about 15 km apart and on opposite sides of the island, it is quite likely that these spiders can be found in suitable habitats all over the island.

Liphistius kanthan Platnick, in Platnick, Schwendinger & Steiner, 1997

Figs 1B, 10-11

Liphistius kanthan Platnick, in Platnick, Schwendinger & Steiner, 1997: 6-9, figs 12-13 (description of female).

Type: AMNH; female holotype (not examined); Malaysia, Perak, Gua (= cave) Kanthan; IX.1996; leg. H. Steiner.

Material examined: MHNG; 3 males (matured 9.VII.1998, 7.II.1999, 22.V.1999), 2 females, 2 immature males; Malaysia, Perak, Gua Kanthan, 60 m, 4°45'41"N, 101°07'15"E; 14.XII.1997; leg. P.J. Schwendinger & L. Price. – MHNG; 1 male (matured 14.IX.1998), 1 female, 1 immature male; Malaysia, Perak, Gua Tempurung, 4°25'02"N, 101°11'16"E; 13.XII.1997; leg. P.J. Schwendinger & L. Price.

Diagnosis: Similar to *L. laruticus*, distinguished by smaller body size and lighter body colouration; males different by much shorter, obliquely truncate para-embolic plate with retroventral-distal corner protruding further than proventral-distal corner (Fig. 10G-I cf. Fig. 7A, E), by less distinct proventral contrategular process (Fig. 10E-F cf. Fig. 7D, F-H), by less pronounced, shorter tegulum (distal edge smaller, proximal edge with fewer denticles; Fig. 10J cf. Fig. 7B), by having two enlarged spinules on retrolateral heel of paracymbium (Fig. 10A, C cf. Platnick *et al.*, 1997: figs 14-16), by more elevated cumulus with bristles less inclined from axis of palpal tarsus (Fig. 10A, C cf. Platnick *et al.*, 1997: figs 15-16), and by tibial apophysis being more slender (Fig. 10B, D cf. Platnick *et al.*, 1997: figs 14, 16). Females different from those of *L. laruticus* by poreplate with distinctly projecting processes on lateral margins in a more proximal position, by a distinctly more posteriorly situated CDO, by a longer and basally narrower receptacular cluster, and by a posteriorly much narrower posterior stalk (Fig. 11 cf. Fig. 7J).

Description of male (from Gua Kanthan, matured 9.VII.1998): *Colour in alcohol* (slightly darker in life): Sclerotised parts mostly light brown, except for: black eye mound, light paired patches on pars cephalica of carapace, cream-coloured proximal portion of chelicerae, reddish brown cheliceral fang and reddish brown palpal tarsus; ventral side of legs slightly lighter than dorsal side; membranes of prosoma whitish, membranes of opisthosoma greyish cream-coloured; opisthosomal tergites I-II light brown, others cream-coloured, with light brown spots (mostly along lateral and posterior margins).
Setae on carapace: Distinctly more setae in posterior half than in anterior half; six setae anterior to fovea.
Cheliceral teeth: Eleven small teeth of different sizes on promargin of each cheliceral groove.
Scopula: Only distally divided by a median stripe on all tarsi; very thin and covering distal two-fifths of ventral side of leg tarsus I; equally thin and covering two-thirds of tarsus II; distinctly denser and covering two-thirds of tarsus III; equally dense and covering three-fourths of tarsus IV.
Tarsal claws: Paired claws with 4-5 denticles; unpaired claws of anterior legs with 3-4 tiny denticles, those of posterior legs with 2-3 denticles.
Palp: Tibial apophysis quite wide at base, not set back from distal margin of tibia (Fig. 10B), carrying four very long apical megaspines with filiform tips (Fig. 10B-D). Apical lobes of tarsus little pronounced (Fig. 10L). Paracymbium fairly long and narrow in ventral view (Fig. 10A), moderately deep, its rounded retrolateral heel carrying two enlarged spinules (Fig. 10A, C); slightly elevated cumulus carrying three long thick bristles touching each other at base (Fig. 10A, C). Subtegulum without apophysis. Tegulum with indistinct proximal edge carrying few (4-5) weak denticles arranged in a curved row and pointing distad and ventrad instead of proximad; distal edge weakly pronounced, straight and only partly pigmented (Fig. 10J). Pigmented bridge between tegulum and contrategulum on retrodorsal side of palpal organ disconnected (Fig. 10J). Contrategulum with indistinct, rounded, proventrad- and slightly distad-directed process and with several fine, oblique parallel ridges on prolateral surface; dorsal apex of distal contrategular edge quite widely rounded and unmodified (i.e. without trench-like depression as in *L. langkawi*; Fig. 10E). Para-embolic plate short and obliquely truncate, its distal margin slightly invaginated, its retroventral-distal corner protruding further than its proventral-distal corner (Fig. 10G); no sharp ledge on prolateral side of contrategulum (as present in *L. desultor*). Sclerotised part of embolus proper long and narrow, strengthened by two pronounced longitudinal ribs, with more or less distinct denticles on apex (Fig. 10A, E); membranous part of embolus proper clearly shorter than sclerotised part.
Measurements: Total length 17.45; carapace 6.72 long, 6.42 wide; opisthosoma 7.55 long, 6.52 wide; eye mound 0.95 long, 1.20 wide; palpal coxae 2.16 long, 1.47 wide; labium 0.68 long, 1.37 wide; sternum 3.04 long, 2.25

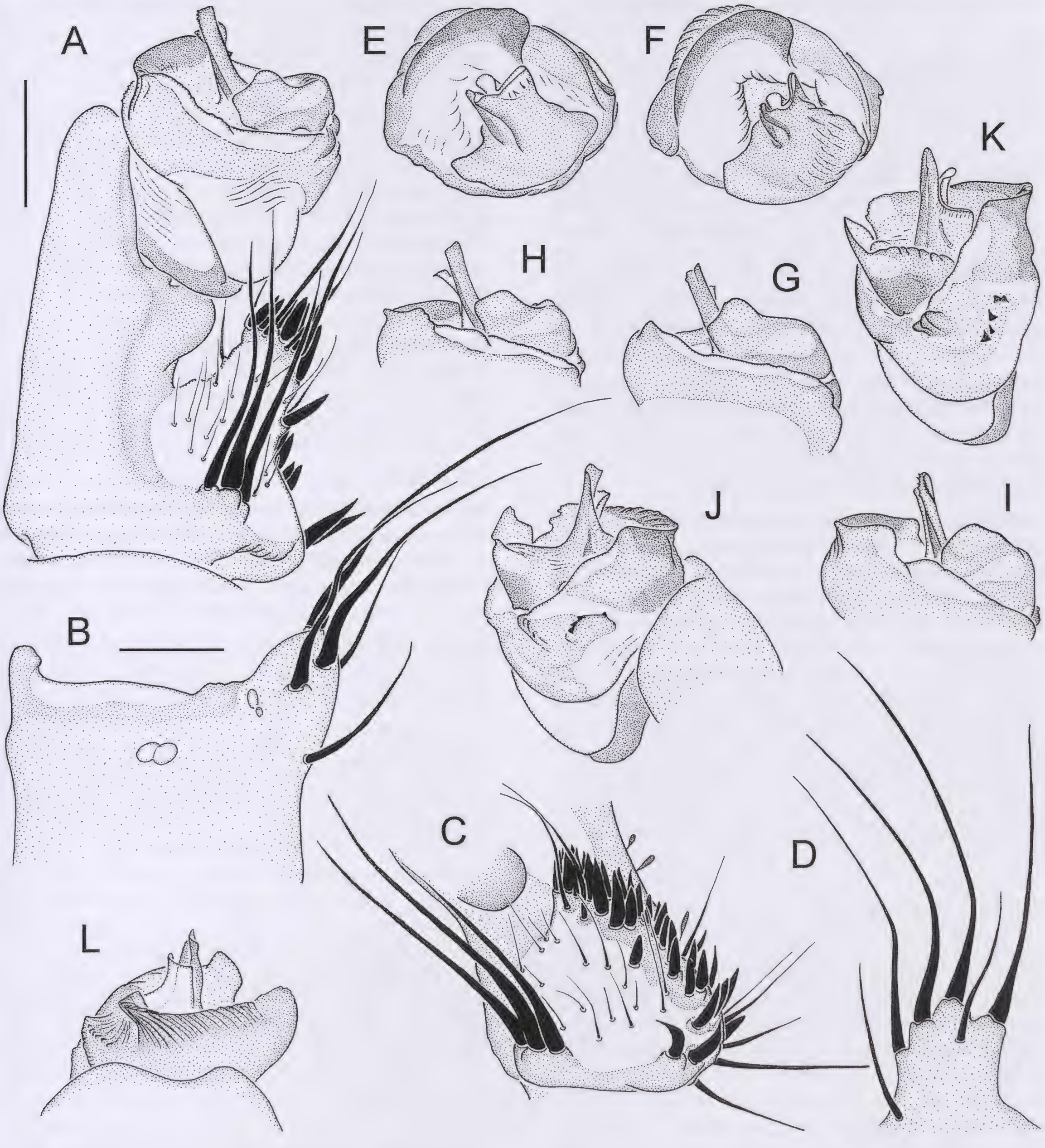


Fig. 10. *Liphistius kanthan*, details of left palp of two males from Kanthan Cave (A-E, G-H, J, L) and of one male from Tempurung Cave (F, I, K); male matured 9.VII.1998 (A-E, G, J, L), male matured 7.II.1999 (H), male matured 14.IX.1998 (F, I, K). (A) Tarsus and palpal organ, ventral view. (B) Distal part of tibia, ventral view. (C) Paracymbium, retrolateral view. (D) Tibial apophysis, retrolateral and slightly proximal view. (E-F) Palpal organ, distal view (dorsal side up). (G-I) Contrategulum and embolus complex, retroventral view. (J-K) Palpal organ, retrodorsal view. (L) Distal margin of tarsus and palpal organ, prodorsal view. Scale lines 0.5 mm (A, C, E-L; B, D).

wide (on ventral surface 0.93); palp 11.67 long (3.73 + 2.16 + 3.92 + 1.86); leg I 23.48 long (6.67 + 2.94 + 5.39 +5.93 + 2.55); leg II 25.83 long (6.96 + 3.04 + 5.88 + 7.06 + 2.89); leg III 28.33 long (7.06 + 3.04 + 6.37 + 8.43 + 3.43); leg IV 35.89 long (8.43 + 3.14 + 8.04 + 11.57 + 4.71).

Additions to description of female: Vulval plate (Fig. 11) clearly wider than long, its posterior margin straight or indistinctly W-shaped. Ventral rim of poreplate with distinct lobes in a position between anterolateral and mediolateral; ventral side of poreplate with quite large vesicles (Fig. 11B, D-F); CDO small, situated in an unusual posterior position (Fig. 11A; see also Platnick *et al.*, 1997: fig. 12); receptacular cluster long, with a narrow stalk and a relatively small and little differentiated head (Fig. 11C); posterior stalk of poreplate strongly pigmented, anteriorly wide, posteriorly with a narrow truncate margin (Fig. 11B, D-F); genital atrium without lateral hairs.

Variation: Carapace length in males (n=4) ranges 6.72-7.54, carapace width 6.27-7.16; in the largest female (out of three examined) it is 7.84 and 7.06, and in the holotype 4.5 and 3.9, respectively. The holotype is thus a quite small female, but its vulva is nevertheless characteristic for the species (Platnick & Sedgwick, 1984: figs 12-13). The two large females from Gua Kanthan examined have protruding lateral processes on the ventral rim of the poreplate, whereas in two small females (holotype from Gua Kanthan and female from Gua Tempurung) these processes are only indicated by swellings (Fig. 11F and Platnick *et al.*, 1997: fig. 13). Variation in details of the male palp is given in Fig. 10. The single male from Gua Tempurung differs from three males from the type locality in a slightly arched distal margin of the para-embolic plate (straight or slightly invaginated in the others) (Fig. 10I cf. Fig. 10A, G-H), in an unbroken (though very narrow) retrodorsal bridge between tegulum and contrategulum, in stronger denticles in a slightly sigmoid row on proximal edge of the tegulum (Fig. 10K), and in both enlarged spinules on the retrolateral heel of the paracymbium with a longer filiform tip. In one male from the type locality the tips of these enlarged spinules are filiform only on one palp, in another male from the same locality only one of the two spinules (on both palps) has a filiform tip. The Gua Tempurung male has the scopula on its left tarsus II slightly shorter than on its right tarsus II. The number of setae anterior to the fovea varies from three to nine. One male from the type locality has lost both AME; another male and a female from the same locality have lost only one of them.

Relationships: Similarities in male and female genitalia show that *Liphistius kanthan* is most closely related to *L. buran* sp. nov. We attribute both species to complex D (see explanation under relationships of *L. buran* sp. nov.).

Distribution: *Liphistius kanthan* is known only from Gua Kanthan and Gua Tempurung (Fig. 2, localities 16 and 17), two limestone caves near Ipoh, in western Peninsular Malaysia. The two caves are 39 km apart. Gua Tempurung is the only know cave to harbour two *Liphistius* species. The limestone formation within which lies Gua Tempurung thus deserves high priority for conservation measures.

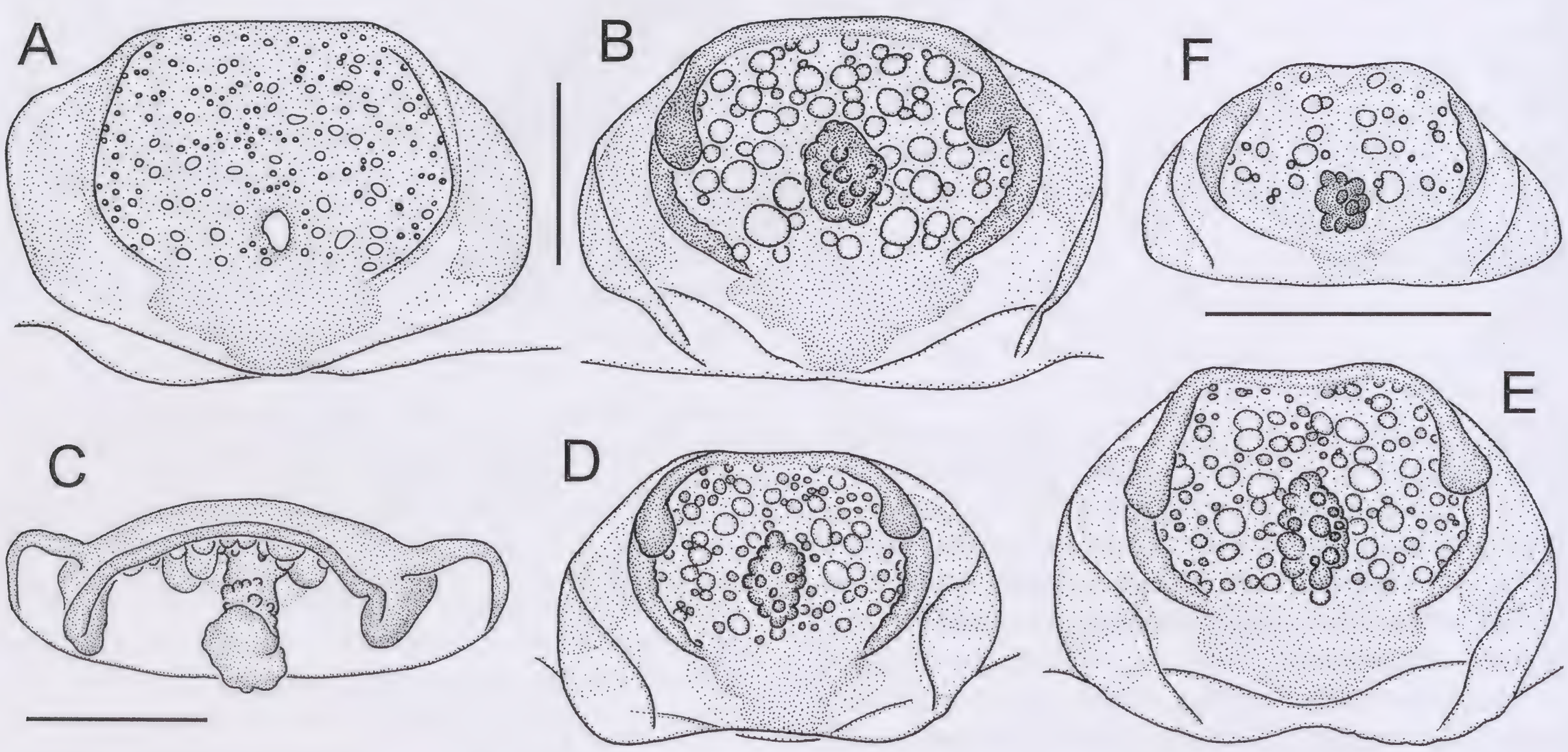


Fig. 11. *Liphistius kanthan*, vulval plate of three fully grown females from Kanthan Cave (A-C; D; E) and of one small female from Tempurung Cave (F). (A) Dorsal view. (B, D-F) Ventral view. (C) Anterior view. Scales 0.5 mm (A-B; C-E; F).

Biology: The spiders examined were collected in the completely dark parts of Gua Kanthan (type locality of *L. kanthan*) and around the entrance of Gua Tempurung (type locality of *L. tempurung* Platnick, in Platnick, Schwendinger & Steiner, 1997, a species of the *batuensis*-group), in the euphotic and oligophotic parts of the cave. Steiner (1998a, b) also reported this species to be quite abundant at the entrance of Kanthan Cave and gave some information on its biology. Apart from a generally light body colouration and some degree of reduction in the AME (also present in many congeners not associated with caves), there is no indication of a morphological adaptation to permanent cave life. Since this species has never been collected away from limestone caves or cave entrances, is very likely to be restricted to such habitats, as it also is the case in *L. priceae* Schwendinger, 2017 (see Schwendinger, 2017: 437).

Males became mature in February, May, September and December, after 7-17 months in captivity, indicating that mating may take place all year round, without a specific mating period. However, this may not correspond to conditions in nature. The first two maturation dates (9.VII.1998 and 14.IX.1998, after seven and nine months in captivity) correspond well with the usual mating period of *Liphistius* species; the later dates (7.II.1999 and 22.V.1999, after 14 and 17 months in captivity) appear artificially delayed.

When collected in mid-December, one of the females had a 1.5 cm wide and 1.2 cm deep egg sac filled with already hatched (at least 2nd instar) spiderlings (not collected; see photos in Price, 1998). This female moulted two days later. The other two females examined (both adult) moulted in February to April, May and June, August and September, and in December, respectively, thus four times a year.

Two of the mature males had 2.9-3.0 cm wide and 1.7-2.0 cm long trapdoors. No other measurements of the burrows were taken.

Conservation status: *Liphistius kanthan* is currently listed by the International Union for Conservation of Nature (IUCN) as a critically endangered species (Whitten *et al.*, 2013) and thus is considered as one of the rarest and most threatened spider species in the world. However, the new find from Gua Tempurung shows that it is not as restricted in its distribution as previously assumed. This species may also occur in and at the entrances of other caves in the area. Several limestone hills exist in the Kinta Valley, but unfortunately many of them are threatened by quarrying for cement production (Price, 1998, 2012, 2013). Thus *L. kanthan* continues to deserve a high degree of protection and its two know localities merit strong conservation efforts.

Liphistius buran Schwendinger, sp. nov.

Figs 12-15

Types: MHNG; male holotype (matured 29.III.1998), female allotype (constructed egg case 13.I.1998, moulted 26.III.1998), 3 males (matured 22.X.1998, 25.XI.1998, 22.XII.1998) and 6 female paratypes; Malaysia, Perak, Pangkor Island, Pangkor Hill (4°14'12"N, 100°34'07"E), 30-150 m; 15.-16.XII.1997; leg. P.J. Schwendinger.

Etymology: Malay: buran = sea anemone. The species epithet, a noun in apposition, refers to the shape of the strongly autapomorphic pad of microtrichia on the palpal organ of this species.

Diagnosis: Distinct from all other congeners by the presence of numerous microtrichia on the distal haematodocha (sensu Kraus, 1978) at the base of the embolus complex on the palpal organ (Figs 13H-I, 14A-E). Similar and apparently most closely related to *L. kanthan*. Both sexes distinguished from those of *L. kanthan* by a distinctly darker colour pattern, in particular by two paramedian bands in front of fovea (Fig. 12A-B). Males additionally different by one (two in *L. kanthan*) enlarged spinule on retrolateral-proximal heel of paracymbium (Fig. 13A, C cf. Fig. 10A, C), by less distinct denticles on distad-turned proximal margin of tegulum (Fig. 13E cf. Fig. 10J-K), by a long proventral contrategular process (indistinct in *L. kanthan*; Fig. 13H-I cf. Fig. 10E-F), by a slightly longer para-embolic plate (Fig. 13G cf. Fig. 10G-I) and by an urn-shaped major embolic fold (Figs 13E-F, H-I, 14A-C, F-G cf. Fig. 10E-F). Females distinguished from those of *L. kanthan* by the complete absence of a posterior stalk on vulval plate (Fig. 15 cf. Fig. 11) and by a less strongly raised receptacular cluster (Fig. 15C cf. Fig. 11C).

Description of male (holotype): *Colour in alcohol* (darker in life): Carapace with light brown basic colouration; anterior portion of pars cephalica with dark brown pattern around two parallel, lancelolate light paramedian patches behind very dark eye mound; posterior portion of pars cephalica with a conspicuous pair of brown paramedian bands anterior to brown fovea, these bands not reaching brown areas of pars cephalica and carrying six very short setae; pars thoracica mostly light brown, with a few dark specks in central part and with irregularly shaped brown lateral patches on coxal elevations (Fig. 12A). Chelicerae with proximal portion cream-coloured; distal portion light brown, with darker longitudinal bands. Annulated legs and palps with light brown basic colouration and dark brown rings: femora with proximal and subdistal rings (the latter indistinct on palps), tibiae only with proximal rings (indistinct on leg IV), metatarsi with indistinct proximal rings (hardly discernible on posterior legs), leg tarsi uniformly light brown, palpal tarsi reddish brown. Opisthosoma with

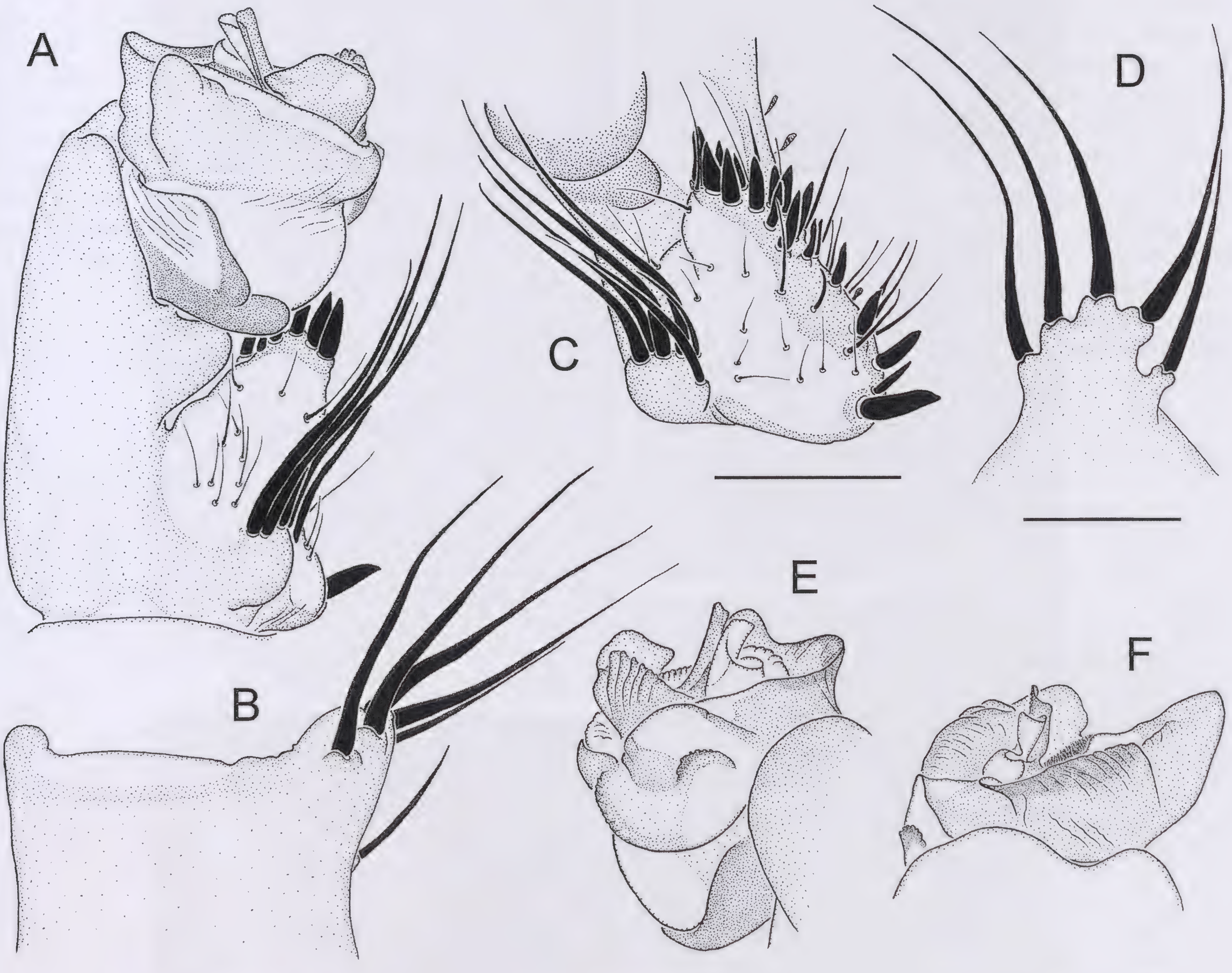
cream-coloured membranous cuticle and mostly light brown tergites with lateral and paramedian pairs of irregular dark spots decreasing in size from anterior to posterior tergites: pair of dark paramedian spots large and medially confluent on tergite I, medially separated on tergite II, fragmented into two pairs on tergite III, rudimentary on tergite IV, absent on subsequent tergites.
Setae on carapace: Distinctly more setae in posterior half than in anterior half; six setae in two parallel rows (on brown bands) anterior to fovea.
Cheliceral teeth: Twelve and thirteen small teeth of different sizes (some hardly discernible) on promarginal groove of left and right chelicera, respectively.
Scopula: Only distally divided by median stripe on all tarsi; indistinct, not clearly outlined, composed of few scattered scopuliform setae in distal third of ventral side of leg tarsus I; equally thin and covering distal half of tarsus II; distinctly denser, clearly outlined, covering three-fourths of tarsus III and tarsus IV.
Tarsal claws: Paired claws with 3-4 denticles on tarsi I-II, three denticles on tarsus III, four denticles on tarsus IV; unpaired claw of tarsi I-III bare, of tarsus IV with one tiny denticle.
Palp: Tibial apophysis basally moderately wide in ventral view, not set back from distal margin of tibia (Fig. 13B), carrying five very long apical megaspines with filiform tips, all of them at different angles to axis of tibia (Fig. 13B, D). Apical lobes of tarsus little pronounced (Fig. 13F). Paracymbium fairly long and narrow in ventral view, moderately deep, its rounded retrolateral-proximal heel carrying one enlarged spinule (Fig. 13A, C); slightly elevated cumulus carrying five long thick bristles, most of them touching each other at the base (Fig. 13A, C). Subtegulum without apophysis. Tegulum little developed, with indistinct proximal edge turned distad and carrying a series of indistinct denticles in a curved row; distal edge distinct, widely arched and only partly pigmented (Fig. 13E). Pigmented bridge between tegulum and contrategulum on retrolateral side of palpal organ widely disconnected (Fig. 13E). Contrategulum with quite long and pointed proventral process (Fig. 13H); with a few very fine, oblique parallel ridges on prolateral surface (Fig. 13F); without a sharp ledge on prolateral surface (as present in *L. desultor*); dorsal apex of distal edge very narrowly rounded, almost triangular (Fig. 13H). Soft membrane (= distal haematodocha) at base of embolus complex densely covered with microtrichia of unknown function (Fig. 13H; see also Figs 13I, 14A-E for paratypes). Para-embolic plate with widely truncate apex, its retroventral-distal corner more protruding than its proventral-distal corner (Fig. 13H; see also Fig. 13G for paratype). Embolus proper narrow, sclerotised part strengthened by two longitudinal ribs, with more or less pronounced denticles on apex (Fig. 13A, H); membranous part of embolus proper only slightly shorter than sclerotised part; major embolic fold urn- or pitcher-shaped, with its two opposing walls widely separated at base (best seen in alcohol-preserved specimens; Fig. 13E-F, H; see also Figs 13I, 14A-C, F for paratypes and "Variation").
Measurements: Total length 11.73; carapace 5.20 long, 4.64 wide; opisthosoma 4.41 long, 3.19 wide; eye mound 0.83 long, 1.03 wide; palpal coxae 1.69 long, 1.10 wide; labium 0.47 long, 0.94 wide; sternum 2.32 long, 1.73 wide (on ventral surface 0.87); palp 9.06 long (2.68 + 2.05 + 2.83 + 1.50); leg I 15.68 long (4.33 + 2.17 + 3.39

Fig. 12. *Liphistius buran* sp. nov. (A) Prosoma of male holotype, dorsal view (note bite marks on carapace). (B) Same of male paratype (matured 22.X.1998). (C) Opisthosoma of male paratype (matured 22.X.1998) with deformed tergites II-IV, dorsal view. Not to scale.

+ 3.90 + 1.89); leg II 16.38 long (4.45 + 2.17 + 3.54 + 4.25 + 1.97); leg III 18.04 long (4.41 + 2.17 + 3.78 + 5.20 + 2.48); leg IV 23.98 long (5.59 + 2.36 + 5.20 + 7.40 + 3.43).

Description of female (allotype): *Colour in alcohol* (distinctly darker in life): Mostly as in male, but dark areas on pars cephalica and on coxal elevations of carapace smaller; two dark paramedian bands anterior to fovea indistinctly connected to dark pattern behind eye mound. Distal part of chelicerae distinctly darker; ventral side of body slightly darker. Dark annulations on all leg articles and on most palpal articles more distinct; palpal tarsus with light brown area in proximal two-thirds, rest of article dark brown.

Setae on carapace: Slightly longer than in male; eight setae in two parallel rows on dark bands anterior to fovea.



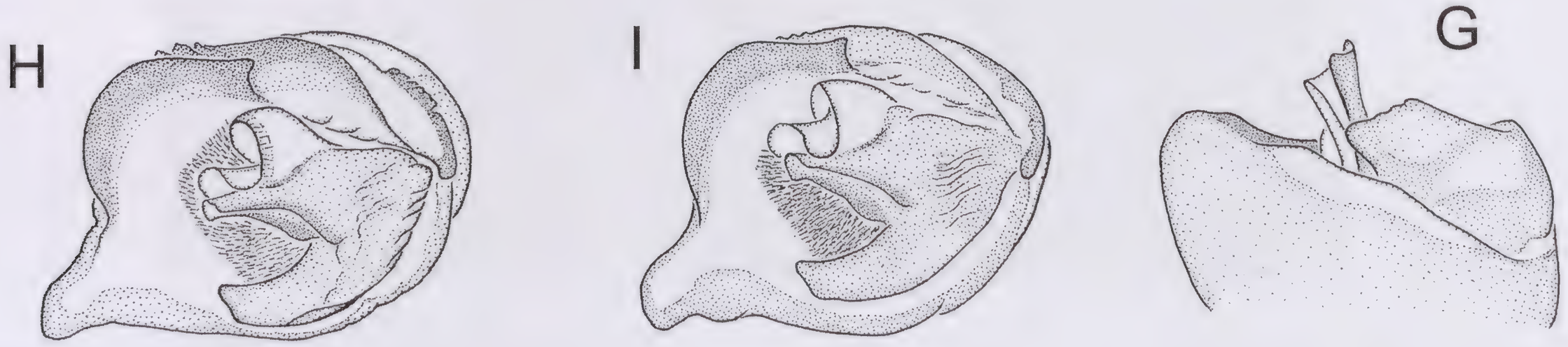


Fig. 13. *Liphistius buran* sp. nov., details of left male palp; holotype (A-F, H), paratype matured 22.XII.1998 (G), paratype matured 25.XI.1998 (I). (A) Tarsus and tarsal organ, ventral view. (B) Distal part of tibia, ventral view. (C) Paracymbium, retrolateral view. (D) Tibial apophysis, retrolateral and slightly proximal view. (E) Palpal organ, retrodorsal view. (F) Distal margin of tarsus and palpal organ, prodorsal view. (G) Contrategulum and embolus complex, retroventral view. (H-I) Palpal organ, distal view (dorsal side up). Scale lines 0.5 mm (A-C, E-I; D).

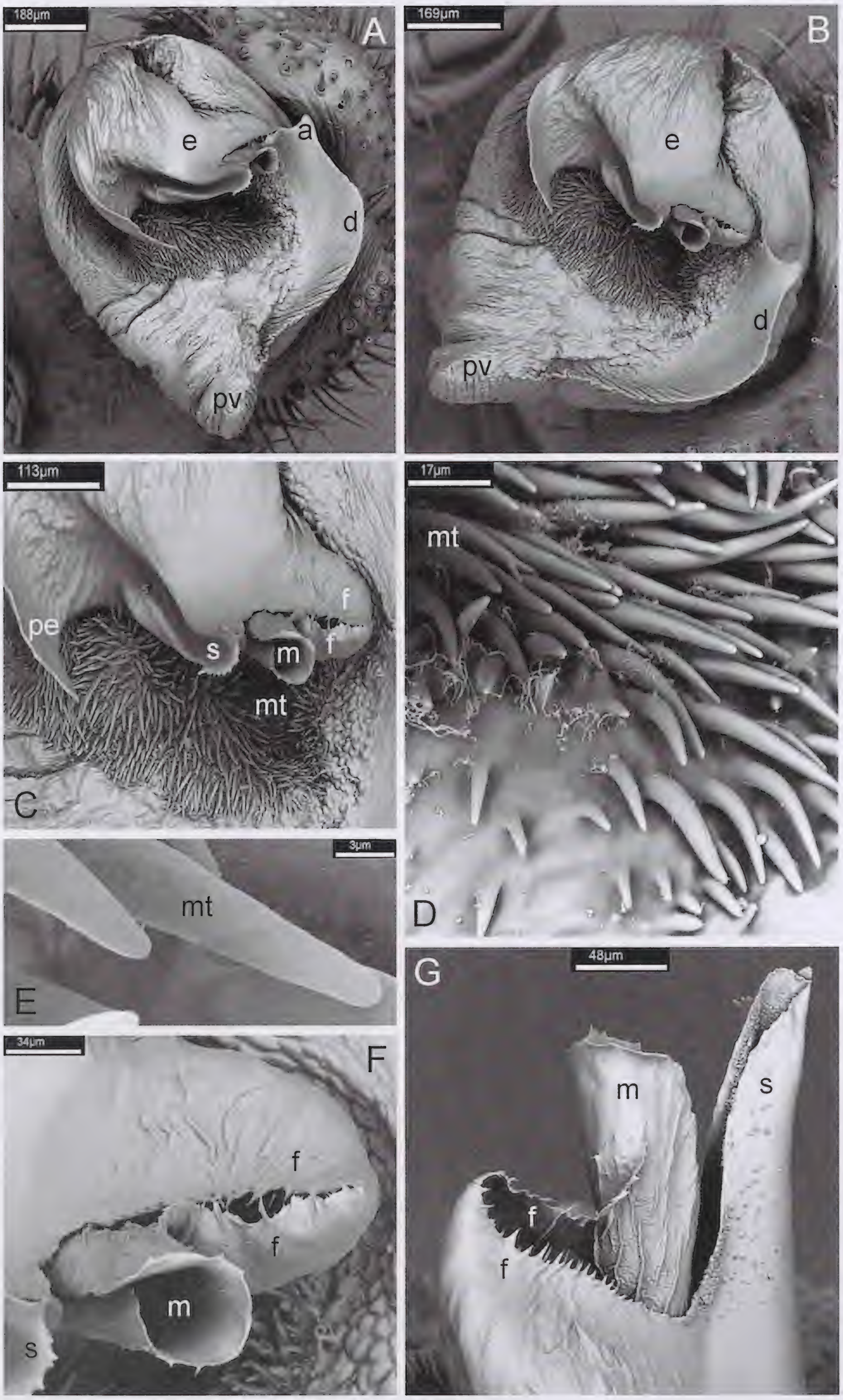


Fig. 14. *Liphistius buran* sp. nov., SEM-micrographs of right palpal organ of male paratype (matured 22.X.1998). (A) Whole palpal organ, distal view showing pad of microtrichia on membrane at base of embolus complex. (B) Same, rotated clockwise on longitudinal axis for about 50°. (C) Detail of embolus complex and microtrichia, approximately same view as in B. (D) Margin of microtrichia pad. (E) Apices of two microtrichia. (F) Part of embolus proper, approximately same view as in A. (G) Embolus proper, dorsal view. Abbreviations: a = dorsal apex of distal edge of contrategulum; d = distal edge of contrategulum; e = embolus complex; f = major embolic fold; m = membranous part of embolus proper; mt = microtrichium, microtrichia; pe = para-embolic plate; pv = proventral process of contrategulum; s = sclerotised part of embolus proper.

Cheliceral teeth: Eleven strong teeth on promargin of groove of right chelicera, twelve on left chelicera.
Claws: Palpal claw with two denticles. Paired tarsal claws of anterior legs with 2-4 denticles, of posterior legs with 2-3 denticles; unpaired claws of anterior legs with 2-4 denticles, of posterior legs with 2-3 denticles. All tarsi without scopula.
Vulva (Fig. 15A-C): Vulval plate distinctly wider than long. Genital atrium remarkably short, strongly bent ventrad, without posterior stalk; lateral folds on ventral side of vulval plate well developed, without hairs. Poreplate with slightly and very widely invaginated, only slightly incrassate anterior margin and with strongly incrassate lateral margins ending in prominent, rounded anterolateral lobes; posterior margin of poreplate with irregular outline, situated just behind small CDO, the latter thus in an unusual posterior position on poreplate; receptacular cluster racemose, longer than wide.
Measurements: Total length 15.40; carapace 5.95 long, 5.00 wide; opisthosoma 5.99 long, 4.68 wide; eye mound 0.82 long, 0.97 wide; palpal coxae 2.06 long, 1.43 wide; labium 0.71 long, 1.43 wide; sternum 2.86 long, 2.38 wide (1.19 on ventral surface); palp 10.04 long (3.33 + 1.87 + 2.46 + 2.38); leg I 13.38 long (4.05 + 2.26 + 2.78 + 2.70 + 1.59); leg II 13.74 long (4.05 + 2.26 + 2.82 + 2.94 + 1.67); leg III 14.64 long (4.05 + 2.30 + 2.90 + 3.41 + 1.98); leg IV 19.65 long (5.24 + 2.46 + 4.13 + 5.28 + 2.54).

Variation: Carapace length in males (n=4) ranges 5.20-6.23, carapace width 4.64-5.52; in the largest female (out of six examined) it is 6.59 and 5.48, respectively. The number of setae anterior to the fovea varies from six to eight in males and from seven to ten in females. In all specimens examined both AME are well developed. In two males the scopula is slightly more distinct on tarsus II, and the scopula on tarsi III-IV is slightly more extensive (covering four-fifths of ventral side of article) than in the other two males (including the holotype; covering three-fourths). Variation in details of the male palp is given in Fig. 13. Three males have a single enlarged spinule (longer and thicker than others nearby) on the proximal-retrolateral heal of the paracymbium of both palps; in the fourth male that

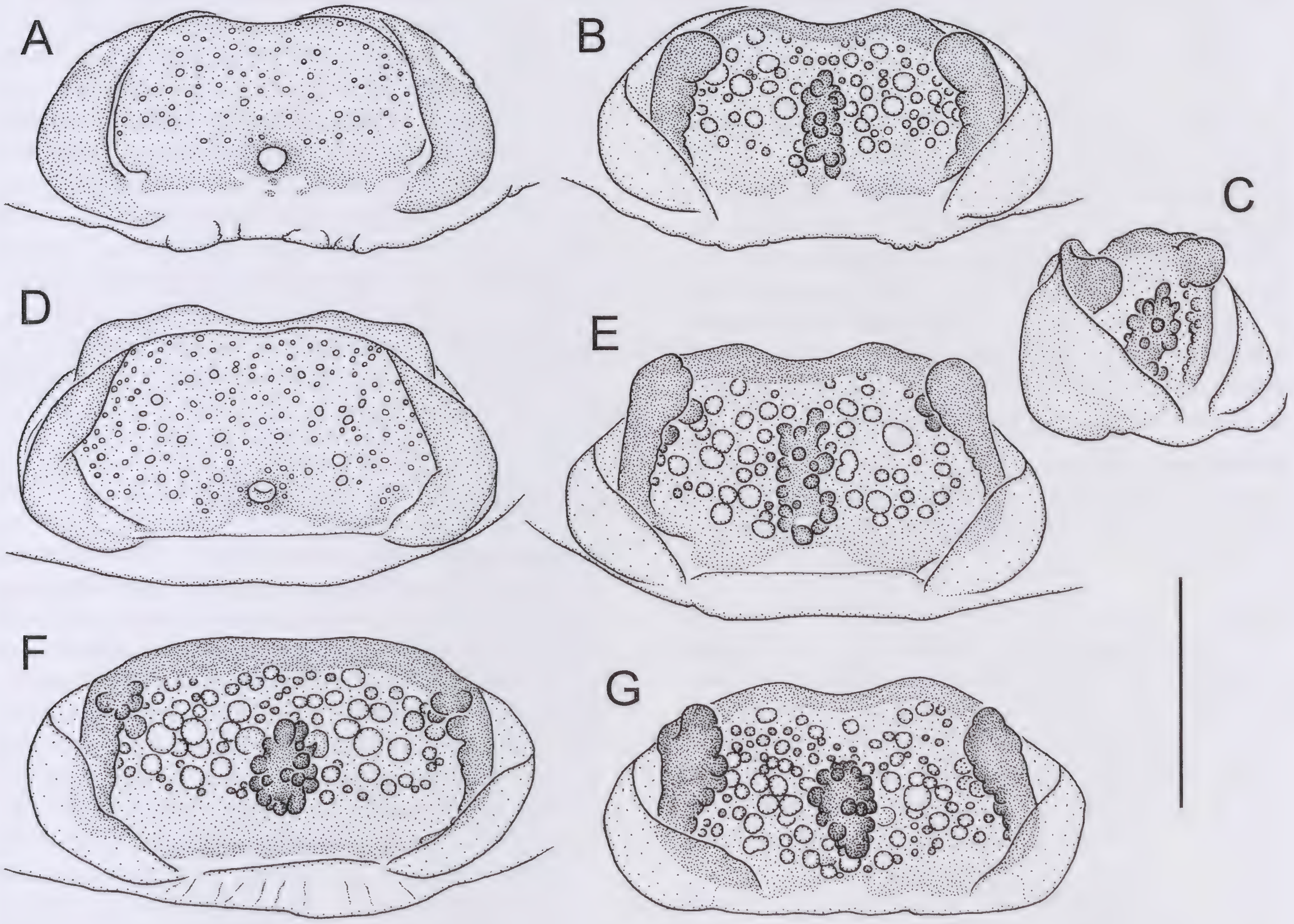


Fig. 15. *Liphistius buran* sp. nov., details of vulval plate from exuviae of four females; allotype (A-C), paratype moulted 3.VIII.1999 (D-E), paratype moulted 29.VIII.1998 (F), paratype moulted 24.V.1998 (G). (A, D) Dorsal view. (B, E-G) Ventral view. (C) Lateral view. Scale line 0.5 mm (A-G).

modified spinule is recognizable only on one palp. In the dried palp used for SEM examination the distal margins of the major embolic fold (as well as the lateral margins of the membranous part of the embolus proper) are bent towards each other (Fig. 14B-C, F) and thus obscuring the urn-shaped form of the major embolic fold that is visible in alcohol-preserved palps (Fig. 13E-F, H-I). This is due to the deformation of thin, membranous cuticle caused by drying. Variation in the shape of the vulval plate is shown in Fig. 15. One of the male paratypes (matured 22.X.1998) shows a rare deformation of opisthosomal tergites II-IV (Fig. 12C).

Relationships: The vulval plate of this species strongly resembles that of species complex C (*L. fuscus, L. phuketensis* and *L. schwendingeri*) from southern Thailand in being wide and short, without a posterior stalk (Fig. 15 cf. Schwendinger, 1995: figs 18-20 and Schwendinger, 1998: fig. 5G-I), but it has distinct anterolateral lobes on the ventral rim of the poreplate. As males of *L. buran* sp. nov. do not possess a large tegulum and a distal contrategulum edge with a series of distinct wrinkles as characteristic for males of species complex C, we consider the new species more closely related to the species of complex D (*L. albipes, L. bicoloripes, L. castaneus, L. desultor, L. kanthan, L. laruticus, L. niphanae, L. sumatranus, L. trang, L. yangae*). This is also more consistent with biogeography: *L. kanthan*, which appears to be most closely related to *L. buran* sp. nov., is also geographically close (Fig. 2, localities 16-17 and 18). Both species share a similar vulval plate (with the CDO situated in a clearly more posterior position than in females of other congeners in Malaysia; presumably a synapomorphy) and a similar male palp (weakly developed tegulum, para-embolic plate with obliquely truncate distal margin, presence of 1-2 enlarged spinules on retrolateral heel of paracymbium).

Distribution: The new species is known only from Pangkor Island (= Pulau Pangkor) off the coast of Perak State, in the west of Peninsular Malaysia (Fig. 2, locality 18).

Biology: The spiders examined were found on sloping earth banks along an old logging road in a dense rainforest at the foot of Pangkor Hill (= Bukit Pangkor). Most burrows had only a single trapdoor, a few burrows were T-shaped and had two doors. Penultimate males had the front door 1.0-1.4 cm long and 1.6-2.1 cm wide (n = 4), and the back door (if present) 1.2-1.5 cm long and 1.7-2.1 cm wide (n = 2). The largest female had a single, 1.5 cm long and 2.1 cm wide door.
In captivity, in late January 1998, two of the females constructed egg cases, 1.9-2.1 cm in diameter and 1.3-1.5 cm deep, containing 33 and 56 light yellow eggs suspended on a fine mesh of silk threads. The spiders subsequently moulted in late March and in early April, respectively. The other three females moulted in April to May and again in August to September, twice per year.
Parasitic mites of the genus *Ljunghia* (see Halliday & Juvara-Bals, 2016: 853) were collected from three females and one male (the holotype). Bite marks were left on the carapace (see Fig. 12A) and on the dorsal side of the chelicerae but nowhere else on the body. The largest female has the most bite marks, the smallest female the fewest (only on the carapace).

MOLECULAR PART

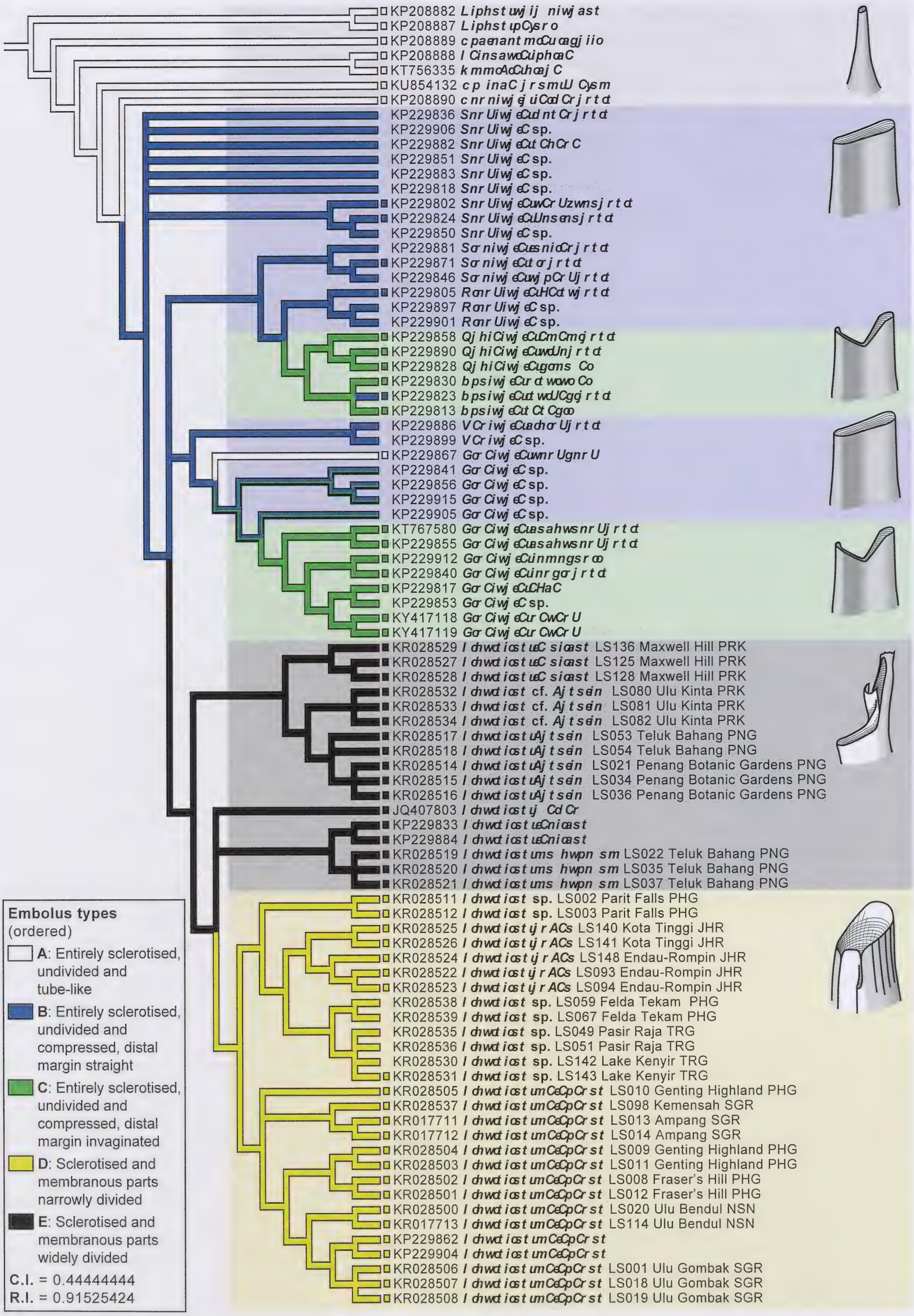
Phylogenetic analysis and character optimization: Monophyly of the family Liphistiidae and of the genus *Liphistius* are recovered with a strong support (both with posterior probability = 1) (Fig. 16), but the evolutionary relationships between *Liphistius* and the remaining liphistiid genera remains unresolved. Within *Liphistius* two relatively well supported groupings were retrieved: (1) a clade comprising *L. desultor*, *L. laruticus* and specimens (not examined by the first author) from Ulu Kinta (near Ipoh), Telok Bahang (Penang Island) and the Penang Botanic Gardens, which probably all belong to *L. desultor* (posterior probability = 0.9993), and (2) a clade that includes *L. endau* Sedgwick & Platnick, 1987, *L. malayanus* Abraham, 1923b, as well as specimens (not examined by the first author) from the Parit Falls (in the Cameron Highlands), Felda Tekam, Pasir Raja and Lake Kenyir, which may belong to undescribed species (posterior probability = 0.9677). The latter group (= clade 2) corresponds to the *malayanus*-group and is characterized by a narrowly divided embolus, whereas the species in clade 1 possess a widely divided embolus. The non-Liphistiinae species (Heptathelinae, Atypidae, Halonoproctidae, Ctenizidae), on the other hand, have an undivided (no division into sclerotised and membranous part) embolus (see Fig. 17).

DISCUSSION

Zoogeography and vulnerability: The syntopic occurrence of two *Liphistius* species (*L. tempurung* and *L. kanthan*) in the interior and at the entrance of the same cave (Gua Tempurung in Perak State) is remarkable and not known from any other cave. On one hand this changes the status of *L. kanthan* as a critically endangered species (see Whitten *et al.*, 2013), on the other hand it highlights the value of Tempurung Cave – and the limestone hill in which it is situated – for conservation. All *Liphistius* "cave species" in Malaysia (i.e. *L. batuensis, L. kanthan, L. panching* Platnick & Sedgwick, 1984, *L. priceae* and *L. tempurung*) are known exclusively from the entrance area (including cliff walls right outside the cave entrance) and from the interior of limestone caves. If a limestone hill with caves harbouring such spiders is quarried, the entire resident *Liphistius* population (or populations in

KP208882 Atypus heterothecus
KP208887 Atypus yajuni
KP208889 Cyclocosmia ricketti
KP208888 Latouchia typica
KT756335 Ummidia picea
KU854132 Cyrtocarenum grajum
KP208890 Conothele taiwanensis
KP229836 Songthela wosanensis
KP229906 Songthela sp.
KP229882 Songthela sapana
KP229851 Songthela sp.
KP229883 Songthela sp.
KP229818 Songthela sp.
KP229802 Songthela hangzhouensis
KP229824 Songthela goulouensis
KP229850 Songthela sp.
KP229881 Sinothela luotianensis
KP229871 Sinothela sinensis
KP229846 Sinothela heyangensis
KP229805 Qiongthela baishensis
KP229897 Qiongthela sp.
KP229901 Qiongthela sp.
KP229858 Heptathela amamiensis
KP229890 Heptathela higoensis
KP229828 Heptathela kimurai
KP229830 Ryuthela nishihirai
KP229823 Ryuthela ishigakiensis
KP229813 Ryuthela sasakii
KP229886 Ganthela cipingensis
KP229899 Ganthela sp.
KP229867 Vinathela hongkong
KP229841 Vinathela sp.
KP229856 Vinathela sp.
KP229915 Vinathela sp.
KP229905 Vinathela sp.
KT767580 Vinathela cucphuongensis
KP229855 Vinathela cucphuongensis
KP229912 Vinathela tomokunii
KP229840 Vinathela tonkinensis
KP229817 Vinathela abca
KP229853 Vinathela sp.
KY417118 Vinathela nahang
KY417119 Vinathela nahang
KR028529 Liphistius laruticus LS136 Maxwell Hill PRK
KR028527 Liphistius laruticus LS125 Maxwell Hill PRK
KR028528 Liphistius laruticus LS128 Maxwell Hill PRK
KR028532 Liphistius cf. desultor LS80 Ulu Kinta PRK
KR028533 Liphistius cf. desultor LS081 Ulu Kinta PRK
KR028534 Liphistius cf. desultor LS082 Ulu Kinta PRK
KR028517 Liphistius desultor LS053 Teluk Bahang PNG
KR028518 Liphistius desultor LS054 Teluk Bahang PNG
KR028514 Liphistius desultor LS021 Penang Botanic Gardens PNG
KR028515 Liphistius desultor LS034 Penang Botanic Gardens PNG
KR028516 Liphistius desultor LS036 Penang Botanic Gardens PNG
JQ407803 Liphistius erawan
KP229833 Liphistius laoticus
KP229884 Liphistius laoticus
KR028519 Liphistius murphyorum LS022 Teluk Bahang PNG
KR028520 Liphistius murphyorum LS035 Teluk Bahang PNG
KR028521 Liphistius murphyorum LS037 Teluk Bahang PNG
KR028511 Liphistius sp. LS002 Parit Falls PHG
KR028512 Liphistius sp. LS003 Parit Falls PHG
KR028525 Liphistius endau LS140 Kota Tinggi JHR
KR028526 Liphistius endau LS141 Kota Tinggi JHR
KR028524 Liphistius endau LS148 Endau-Rompin JHR
KR028522 Liphistius endau LS093 Endau-Rompin JHR
KR028523 Liphistius endau LS094 Endau-Rompin JHR
KR028538 Liphistius sp. LS059 Felda Tekam PHG
KR028539 Liphistius sp. LS067 Felda Tekam PHG
KR028535 Liphistius sp. LS049 Pasir Raja TRG
KR028536 Liphistius sp. LS051 Pasir Raja TRG
KR028530 Liphistius sp. LS142 Lake Kenyir TRG
KR028531 Liphistius sp. LS143 Lake Kenyir TRG
KR028505 Liphistius malayanus LS010 Genting Highland PHG
KR028537 Liphistius malayanus LS098 Kemensah SGR
KR017711 Liphistius malayanus LS013 Ampang SGR
KR017712 Liphistius malayanus LS014 Ampang SGR
KR028504 Liphistius malayanus LS009 Genting Highland PHG
KR028503 Liphistius malayanus LS011 Genting Highland PHG
KR028502 Liphistius malayanus LS008 Fraser's Hill PHG
KR028501 Liphistius malayanus LS012 Fraser's Hill PHG
KR028500 Liphistius malayanus LS020 Ulu Bendul NSN
KR017713 Liphistius malayanus LS114 Ulu Bendul NSN
KP229862 Liphistius malayanus
KP229904 Liphistius malayanus
KR028506 Liphistius malayanus LS001 Ulu Gombak SGR
KR028507 Liphistius malayanus LS018 Ulu Gombak SGR
KR028508 Liphistius malayanus LS019 Ulu Gombak SGR
LIPHISTIIDAE
Liphistius

Fig. 16. 50% majority-rule consensus tree computed from the Bayesian analysis of COI sequences of liphistiid and mygalomorph spiders. Posterior probabilities are indicated for each node.


KP208882 Liphstuwjij niwjast
KP208887 LiphstupCysro
KP208889 cpaenantmoCuoagjiio
KP208888 ICinsawoCuiphoaC
KT756335 kmmoAoCuhoajC
KU854132 cpinaCjrsmuUCysm
KP208890 cnrniwjejuCoolCrjrtot
KP229836 SnrUiwjeCudntCrjrtot
KP229906 SnrUiwjeC sp.
KP229882 SnrUiwjeCutChCrC
KP229851 SnrUiwjeC sp.
KP229883 SnrUiwjeC sp.
KP229818 SnrUiwjeC sp.
KP229802 SnrUiwjeCuwCrUzwnsjrtot
KP229824 SnrUiwjeCuUnsensjrtot
KP229850 SnrUiwjeC sp.
KP229881 SornniwjeCuesnioCrjrtot
KP229871 SornniwjeCutorjrtot
KP229846 SornniwjeCuwjpCrUjrtot
KP229805 RonrUiwjeCuHCotwjrtot
KP229897 RonrUiwjeC sp.
KP229901 RonrUiwjeC sp.
KP229858 QjhiCiwjeCuCmCmgjrtot
KP229890 QjhiCiwjeCuwdUnjrtot
KP229828 QjhiCiwjeCugoms Co
KP229830 bpsiwjeCurotwowoCo
KP229823 bpsiwjeCutwdUCggjrtot
KP229813 bpsiwjeCutCtCgoo
KP229886 VCriwjeCuachorUjrtot
KP229899 VCriwjeC sp.
KP229867 GorCiwjeCuwnrUgnrU
KP229841 GorCiwjeC sp.
KP229856 GorCiwjeC sp.
KP229915 GorCiwjeC sp.
KP229905 GorCiwjeC sp.
KT767580 GorCiwjeCuasahwsnrUjrtot
KP229855 GorCiwjeCuasahwsnrUjrtot
KP229912 GorCiwjeCuinmngsroo
KP229840 GorCiwjeCuinrgorjrtot
KP229817 GorCiwjeCuCHaC
KP229853 GorCiwjeC sp.
KY417118 GorCiwjeCurCwCrU
KY417119 GorCiwjeCurCwCrU
KR028529 IchwtiostuC sioast LS136 Maxwell Hill PRK
KR028527 IchwtiostuC sioast LS125 Maxwell Hill PRK
KR028528 IchwtiostuC sioast LS128 Maxwell Hill PRK
KR028532 Ichwtiost cf. Ajtsein LS080 Ulu Kinta PRK
KR028533 Ichwtiost cf. Ajtsein LS081 Ulu Kinta PRK
KR028534 Ichwtiost cf. Ajtsein LS082 Ulu Kinta PRK
KR028517 IchwtiostuAjtsein LS053 Teluk Bahang PNG
KR028518 IchwtiostuAjtsein LS054 Teluk Bahang PNG
KR028514 IchwtiostuAjtsein LS021 Penang Botanic Gardens PNG
KR028515 IchwtiostuAjtsein LS034 Penang Botanic Gardens PNG
KR028516 IchwtiostuAjtsein LS036 Penang Botanic Gardens PNG
JQ407803 Ichwtiostij CdCr
KP229833 IchwtiostuCnioast
KP229884 IchwtiostuCnioast
KR028519 Ichwtiostums hwpn sm LS022 Teluk Bahang PNG
KR028520 Ichwtiostums hwpn sm LS035 Teluk Bahang PNG
KR028521 Ichwtiostums hwpn sm LS037 Teluk Bahang PNG
KR028511 Ichwtiost sp. LS002 Parit Falls PHG
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KR028524 Ichwtiostij rACs LS148 Endau-Rompin JHR
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KR028530 Ichwtiost sp. LS142 Lake Kenyir TRG
KR028531 Ichwtiost sp. LS143 Lake Kenyir TRG
KR028505 IchwtiostumCeCpCrst LS010 Genting Highland PHG
KR028537 IchwtiostumCeCpCrst LS098 Kemensah SGR
KR017711 IchwtiostumCeCpCrst LS013 Ampang SGR
KR017712 IchwtiostumCeCpCrst LS014 Ampang SGR
KR028504 IchwtiostumCeCpCrst LS009 Genting Highland PHG
KR028503 IchwtiostumCeCpCrst LS011 Genting Highland PHG
KR028502 IchwtiostumCeCpCrst LS008 Fraser's Hill PHG
KR028501 IchwtiostumCeCpCrst LS012 Fraser's Hill PHG
KR028500 IchwtiostumCeCpCrst LS020 Ulu Bendul NSN
KR017713 IchwtiostumCeCpCrst LS114 Ulu Bendul NSN
KP229862 IchwtiostumCeCpCrst
KP229904 IchwtiostumCeCpCrst
KR028506 IchwtiostumCeCpCrst LS001 Ulu Gombak SGR
KR028507 IchwtiostumCeCpCrst LS018 Ulu Gombak SGR
KR028508 IchwtiostumCeCpCrst LS019 Ulu Gombak SGR
Embolus types
(ordered)
A: Entirely sclerotised, undivided and tube-like
B: Entirely sclerotised, undivided and compressed, distal margin straight
C: Entirely sclerotised, undivided and compressed, distal margin invaginated
D: Sclerotised and membranous parts narrowly divided
E: Sclerotised and membranous parts widely divided
C.I. = 0.44444444
R.I. = 0.91525424

Fig. 17. Ancestral state reconstruction of embolus types: A = white, B = blue, C = green, D = yellow, E = black. Characters are mapped onto the maximum clade credibility tree from the Bayesian analysis. The consistency index and retention index, as well as schematic drawing for each character state are provided. Species in which the embolus type is known are marked with a small square at the end of the corresponding branches.

the case of Gua Tempurung) will be wiped out and the already small genepool of the species will be further severely diminished. In the case of *L. priceae*, which is so far only known from two small caves close together in the same limestone hill (Schwendinger, 2017: 437), the entire species could go extinct. A special effort should be made to conserve these rare and charismatic species.

Phylogenetic analysis and character optimization: The gene COI alone does not provide enough signal to resolve the phylogenetic relationships between the various genera in the family Liphistiidae with confidence. Most of the nodes are poorly supported. Moreover, the topology retrieved here (Heptathelinae basal to *Liphistius*) is in contradiction with the phylogeny published by Xu *et al*. (2015b), which was computed from a much larger dataset (five genes, both nuclear and mitochondrial). Therefore only the relationships within *Liphistius* retrieved in our analysis are considered reliable and are discussed here.

The monophyly of *Liphistius* and the grouping of *L. endau*, *L. malayanus* and specimens with uncertain identity from four localities (all included in the monophyletic *malayanus*-group) are congruent with relationships inferred from embolus morphology. Although species of the *trang*-group do not form a monophyletic group, they are placed together as basal to the *malayanus*-group, which is also in congruence with embolus morphology. In the genus *Liphistius* this genital structure is most peculiar: it is split longitudinally on two opposing sides into distinct parts, one sclerotised, the other membranous (see Schwendinger, 2017: fig. 3), whereas in all other spiders, including the closely related Heptathelinae, it forms a closed, often compressed sclerotised tube (see paragraph "Material and methods - morphological methods"). Moreover, within *Liphistius* an undisputable morphological dichotomy clearly distinguishes species of the *trang*-group from the other congeners. Our molecular data show that the species of the *malayanus*-group, in which males possess a narrowly divided embolus, form a monophyletic group that is clearly distinct from species of the *trang*-group, in which males have a widely divided embolus. Although counterintuitive, the present molecular-based phylogeny suggests that the widely divided embolus (*trang*-group) is the primitive state. A more logical sequence would have been the gradual opening of an entire embolus (present in most spiders).

The molecular data also show another incongruence with the interpretation of morphological data. Schwendinger (2017: 395) placed *L. malayanus cameroni* Haupt, 1983, described from specimens collected in the Cameron Highlands, in the synonymy of *L. malayanus*. The two males from the Parit Falls in the Cameron Highlands, however, are quite distinct in their COI sequences from *L. malayanus* specimens collected at six localities outside the Cameron Highlands (Fig. 16). Either the two Parit Falls specimens belong to an undescribed species in the *malayanus*-group, which is quite unlikely, or the taxonomic status of *L. malayanus cameroni* needs to be re-evaluated.

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A revision of the Chilean Brachyglutini – Part 5. Revision of *Achilia* Reitter, 1890: *A. cornuta*, *A. spinifer*, *A. cribratifrons*, *and A. monstrata* species groups (Coleoptera: Staphylinidae: Pselaphinae)

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Abstract: The *A. cornuta*, *A. spinifer*, *A. cribratifrons*, and *A. monstrata* species groups *sensu* Jeannel (1962) of the species-rich genus *Achilia* Reitter, 1890 are revised. Of the ten taxa placed in these four groups of species, two belong to different groups and will be treated in a subsequent part of our revision of *Achilia* (i.e. *A. caneloi* Franz, 1996 and *A. simpsoni* Franz, 1996 with the *A. cosmoptera* and the *A. bicornis* groups, respectively), two names are placed in synonymy – *A. parangulifrons* Franz, 1996 = *A. lobifera* Jeannel, 1962 **syn. nov.**, and *A. monstrata chilota* Jeannel, 1962 = *Achilia monstrata* (Reitter, 1885) **syn. nov.** – and *A. pseudangulifrons* Franz, 1996 is considered as a *species inquirenda*. The remaining five species are redescribed, and the new species *Achilia pullastra* **n. sp.**, attributed to the *A. spinifer* group, and *Achilia pugila* **n. sp.**, attributed to the *A. cribratifrons* group, are described. For all these species the distribution is detailed and mapped, and habitat/collecting data are summarized.

Keywords: *Achilia* - Chile - taxonomy - new species - distribution.

INTRODUCTION

This article is the fifth contribution to our series aiming at a taxonomic revision of the Brachyglutini of the temperate region of southern South America, and the fourth dedicated to the genus *Achilia* Reitter, 1890 (Kurbatov & Sabella, 2015; Sabella *et al.*, 2017; Kurbatov *et al.*, 2018; Sabella *et al.*, 2019).

We here focus on the *A. cornuta*, *A. spinifer*, *A. cribratifrons*, and *A. monstrata* species groups (*sensu* Jeannel, 1962). All the members of these groups are critically reexamined, and their synonymic framework is detailed. These species are redescribed, and two new species placed in these groups are described.

Regarding the prevalence of the spelling of the genus *Achilia* vs *Achillia* see Sabella *et al.* (2017: 120). The species groups of *Achilia* as defined by Jeannel (1962), which are mainly based on male sexual dimorphism, as well as their possible phylogenetic relationships will be reassessed later. A key to identification of the species of *Achilia* will be provided only at the end of this series of contributions.

MATERIAL AND METHODS

This study is based on the examination of 202 specimens. The acronyms used in the present study refer to the following collections (relevant curator/collection manager are acknowledged in parentheses):

DBUC Department of Biological, Geological and Environmental Sciences, University of Catania, Italy

FMNH Field Museum of Natural History, Chicago, U.S.A. (J. Boome)

JEBC Colección Entomológica Y Museo Juan Enrique Barriga – Tuñón, Curicò, Chile (J. E. Barriga – Tuñón)

MHNG Muséum d'Histoire Naturelle, Genève, Switzerland

MNHN Muséum National d'Histoire Naturelle, Paris, France (T. Deuve and A. Taghavian)

MNHS Museo Nacional de Historia Natural, Santiago, Chile (M. Elgueta Donoso and Y. J. Sepulveda Guaico)

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MSNG Museo Civico di Storia Naturale "G. Doria", Genova, Italy (R. Poggi)
NHMW Naturhistorische Museum, Wien, Austria (H. Schillhammer)
PHPC Private collection of Peter Hlavác, Prague, Czech Republic (P. Hlavác)
UNHC University of New Hampshire Arthropod Collection, Durham, NH, U.S.A. (D.S. Chandler)

Under the sections "type material" or "additional material" the locality data are standardized, with indications of major administrative units (regions and provinces) and names of collectors; for the holotypes of older specimens the labels are also given verbatim.
Images were taken using a Leica DFC425 camera in conjunction with a Leica M205-C compound microscope. Zerene Stacker (version 1.04) was used for image stacking. All images were modified and grouped using Adobe Photoshop and Illustrator CS6.
The body length is measured from the anterior clypeal margin to the posterior margin of the last visible abdominal tergite. The length and width of the body parts were measured between points of maximum extension, e.g. the head length is measured between the anterior clypeal margin and the posterior margin of the neck, the head width includes the eyes, the elytral length along the suture line, and the elytral width is the total width of the two elytra taken together. The abdominal tergites are numbered based on order of visibility. Morphological terminology follows that of Chandler (2001), except our use of "ventrite" instead of "sternite" when describing meso- and metathoracic structures, and that the sclerotized features of the dorsal plate of the aedeagus termed "dorsal strips" in Sabella *et al*. (2017) are here termed "longitudinal struts".

TAXONOMY

All the species described below show the following common features. Pubescence decumbent, consisting of long setae sparse and uniform over entire body. Anterior portion of lateral margins of pronotum convergent posteriorly and posterior portion of lateral margins subparallel and sinuate, surface of pronotal disc smooth and shiny with some punctures; basal margin of pronotum bordered with row of contiguous shallow impressions. Elytra together wider than long (only in *A. cribratifrons* slightly wider than long) with protruding humeri; elytral disc smooth, shiny, with punctures; sutural stria entire. Abdomen smooth, with some minute punctures; first abdominal tergite with short and sparse setal brush between basal striae. Legs with trochanters elongate; profemora and mesofemora of male slightly thickened.
In order to keep the text more concise, these features are not repeated in their respective descriptions.

Achilia cornuta species group

Jeannel (1962: 397, 415) characterized this group as follows: elytra with 3 basal foveae; basal striae of first abdominal tergite separated at most by one-third of tergal width; head with frons of male with highly raised and pubescent median horn overhanging narrow transverse fissure; antennomeres of male antennal club modified. Parameres of aedeagus without setae, and internal sac with two large subequal copulatory pieces. The group includes only *A. cornuta* Jeannel, 1962.

Achilia cornuta Jeannel, 1962

Figs 1, 12, 18, 27, 34-35, 55

Achilia cornuta Jeannel 1962: 415, figs 169 (habitus), 170 (head), 171 (aedeagus).

Type material (3 ex.): MHNS; 1 ♂ (holotype); Chili; labels verbatim "Type / Chili / *Achillia cornuta* / *Achillia cornuta* (handwritten by Jeannel) / CHILE, M.N.H.N., Typo, n. 1778". – MNHN; 2 ♂ (paratypes); labels verbatim "Paratype / Chili, Germain / *A. cornuta* (handwritten by Jeannel) ".

Additional material examined (80 ex.): SOUTHERN AND CENTRAL CHILI: Región Aysén: Aysén prov.: MHNG; 2 ♂; 30 km N Puyuhuapi, station 107; 100 m; 29.I.1985; S. & J. Peck. – DBUC; 1 ♂; same data. – Región Los Lagos: Osorno prov.: FMNH (FMHD #85-933, #85-48); 2 ♂; 3 km S Maicolpué, Bahia Mansa; 200 m; 03.II.1985; S. & J. Peck; mixed forest litter. – MHNG; 19 ♂ and 11 ♀; same locality; 21.XII.1984; S. & J. Peck; mixed forest litter. – DBUC; 1 ♀; same data. – FMNH; 1 ♂ and 1 ♀; Hills S of Maicolpué; 160 m; 21.XII.1982; A. Newton & M. Thayer; 2ª Valdivian forest, berlese, leaf & log litter, forest floor. – FMNH (FMHD #2002-087); 3 ♀; Puyehue National Park, W side Paso Cardenal Samoré; 40° 42.65'S 71° 56.66'W; 1305 m; 17.XII.2002; A. Newton, M. Thayer & A. Solodovnikov 1069; timberline *Nothofagus pumilio* forest with snow patches, berlese, leaf & log litter. – Región Los Ríos: Ranco prov: MHNG; 2 ♂ and 2 ♀; 34 km WNW La Unión, station 36; 700 m; 17.XII.1984; S. & J. Peck; litter mixed evergreen forest. – MHNG; 12 ♂ and 7 ♀; 35 km WNW La Union; 700 m; 07.II.1985; S. & J. Peck; litter mixed forest. – Valdivia prov: PCPH; 2 ♂; 12 km NW of Valdivia; WDS-T-201; 39° 42'S 73° 19'W; 21-22.II.2008; W.D. Shepard; sifting litter. – Región Araucanía: Cautín prov.: MHNG; 3 ♂ and 1 ♀; Huerquehue National Park, Lago Cicho, station 18a; 1250-1350 m; 23.XII.1990; M. Agosti & D. Burckhardt; forest litter. – FMNH (FMHD #96-239); 1 ♂; Villarica National Park, Volcàn Villarica, road to sky center; 39° 22.48'S 71° 58.30'W; 1180 m; 26.XII.1996/03.II.1997; A. Newton & M. Thayer 980; *Nothofagus dombeyi* forest w/*Chusquea*, berlese, leaf & log litter. – FMNH; 2 ♂; Volcán Villarrica, site 653; 1250 m; 15-29.XII.1982; A. Newton & M. Thayer;

Nothofagus dombeyi/pumilio forest w/*Chusquea*, berlese, leaf & log litter, forest floor. – UNHC; 2 ♂; same data; A. Newton & M. Thayer. – FMNH; 1 ♂; same locality; 15-29.XII.1982; A. Newton & M. Thayer; *Nothofagus dombey/pumilio* forest w/*Chusquea*, flight intercept (windows) trap. – Región Bio Bio: Ñuble prov.: FMNH; 1 ♀; Las Trancas 19.5 km ESE Recinto, site 647; 1250 m; 10.XII.1982/03.I.1983; A. Newton & M. Thayer; *Nothofagus* forest, berlese, leaf & log litter. – MHNG; 3 ♀; 10 km W Termas de Chillán, station 5a; 1250 m; 12-13.XII.1990; M. Agosti & D. Burckhardt; *Nothofagus* forest litter.

Description: Body 1.30-1.40 mm long, entirely dark brown with reddish, reddish-brown, or sometimes brown elytra; antennae and legs reddish, palpi yellowish, more or less darkened at apex. Head wider than long with vertexal sulcus impressed. Pronotum wider than head and wider than long, with disc slightly convex; median antebasal fovea slightly smaller than lateral ones. Elytra with four basal foveae (two lateral foveae very close and sometimes coalesced to form one very large fovea); discal stria extending to less than elytral midlength.

First abdominal tergite with diverging basal striae extending to about one-fourth of paratergal length, and separated at base by about one-third of tergal width; first abdominal sternite with large median carina extending from its posterior margin to about one-third of its length.

Male: Head as in Figs 34-35, with occipital region strongly raised as median protuberance separated by deep transverse sulcus from frons, the latter also raised at middle. Anterior portion of frons and frontal lobe flattened and shiny. Eyes protruding and about as long as slightly convex temples. Antennae (Fig. 12) with scape and pedicel longer than wide; antennomeres III-VI distinctly wider than long, antennomere VII slightly wider than long, its mesal margin slightly widened, VIII strongly transverse, its mesal margin distinctly protruding at middle, the latter antennomere bearing one long seta, two other long setae inserted near lateral margin; antennomere IX flattened and strongly transverse with very protruding mesal margin pointed at middle, and bearing 4-5 long setae, while four other long setae are inserted near lateral margin; antennomere X large and slightly wider than long, bearing some long setae on its mesal margin, its basal half excavated; antennomere XI very elongate, with denticulate margins, and distinctly longer than VII-X combined, bearing two long subbasal setae on mesal margin. Metaventrite raised at middle, with wide medial sulcus. Ventral margin of protrochanters projecting at middle as very small spine (Fig. 18), surface of mesotrochanters bearing numerous long bristles; mesotibiae with bifid subapical spur on medial margin (Fig. 27), distal half of metatibiae slightly sinuate. Abdominal tergites and sternites unmodified. Aedeagus (Fig. 1, dorsal longitudinal struts not shown) 0.35-0.36 mm long; with quadrangular dorsal plate, dorsal longitudinal struts reduced and divergent; internal sac with pair of large and subequal medial sclerites pointed at their apex, apices curved laterad. Parameres wide with one thin seta on small outer lobe; tips enlarged, bearing two thin subapical setae.

Female: The female of this species had not been previously described. It is similar to the male except: head not modified, but with posterior part of frons and occipital region distinctly convex at middle, and with large vertexal foveae beside each eye; eyes smaller than for male, shorter than temples; antennae unmodified, thinner than for male; metaventrite and legs unmodified.

Collecting data: Collected from December to February, in different types of forests at elevations ranging from 100 m to 1350 m. All specimens came from sifted samples of leaf and log litter, except for one specimen collected by flight intercept traps.

Distribution: *Achilia cornuta* was generically mentioned for Chile in the original description, without further indication of locality, although Jeannel (1962: 416) mentioned that the specimens could have come from the Valdivian forest of Chillàn or of Pemehue. Based on our data, the species is distributed in Southern and Central Chile (Fig. 55: red circles), ranging from Aysén province to Ñuble province.

Comments: The male of this species is easily distinguished from its congeners by the shape of the head (Figs 34-35), antennae (Fig. 12), and aedeagus (Fig. 1).

Achilia spinifer species group

Jeannel (1962: 397, 415) characterized this group as follows: elytra with 2 basal foveae; basal striae of first abdominal tergite separate at most by one-third of tergal width; frons of male with two lateral pits with outer edge toothed; antennomere II of male modified, depressed and toothed; internal sac of aedeagus with two large copulatory pieces.

The group currently includes only *A. spinifer* Jeannel, 1962, to which we add here *A. pullastra* n. sp., decribed below.

Achilia spinifer Jeannel, 1962

Figs 2, 10, 21, 28, 40, 42, 44, 55

Achilia spinifer Jeannel 1962: 416, figs 172 (head and antennae), 173 (aedeagus).

Type material (38 ex.): CENTRAL CHILI: Región Coquimbo: Elquì prov.: MHNS; 1 ♂ (holotype) labels verbatim "Type / Talinay, 23.X.1957, G. Kuschel / *Achillia spinifer* / *Achillia spinifer* (handwritten by Jeannel) / CHILE, M.N.H.N., Typo n. 1779". – MNHN; 4 ♂ and 5 ♀ (paratypes); labels verbatim "Paratype

/ Talinay, 23.X.1957, G. Kuschel / *Achillia spinifer* (handwritten by Jeannel)". – MNHN; 13 ♂ and 15 ♀ (paratypes); labels verbatim "Paratype / Talinay, 16.X.1957, G. Kuschel".

Additional material examined (18 ex.): CENTRAL CHILI: Región Coquimbo: Elquì prov.: MHNS; 11 ♂ and 2 ♀ (mislabelled as paratypes of *Achilia spinifer* n. 1780-1792); Talinay; 23.X.1957. – MHNS; 3 ♂ (mislabelled as paratypes of *Achilia spinifer* n. 1793-1795); same locality; 16.X.1957; G. Kuschel. – MHNS; 1 ♂ (mislabelled as paratype of *Achilia spinifer* n. 1796); same locality; 22.XI.1954; G. Kuschel. – MHNG; 1 ♂; Bsq. Talinay; costa S Coquimbo; 22.IV.1955; L. E. Peña.

Description: Body 1.70-1.85 mm long, entirely dark brown with reddish, or reddish-brown elytra; antennae and legs reddish, and palpi yellowish, sometimes slightly darker. Head with eyes not very protruding, shorter than convex temples. Pronotum wider than long; pronotal disc convex; median antebasal fovea as large as lateral ones, but shallower. Elytra with three basal foveae (two lateral foveae very close, sometimes coalesced as one large fovea); discal stria extending to about elytral midlength. First abdominal tergite with basal striae extending to about one-quarter of paratergal length, and separated at base by about one-third of tergal width. First abdominal sternite with median carina extending from its posterior margin to about one-quarter of its length.

Male: Head as in Figs 40, 42, 44, with temporal spine above and behind each eye, temporal spine bordered at base by large pit. Vertex slightly raised at middle, its surface smooth and shiny; frons raised and slightly enlarged, dorsally bearing large punctures. Anterior margin of frontal lobe distinctly concave at middle. Clypeus bearing stout medial tooth with two large apical setae. Antennae (Fig. 10) with scape longer than wide, with mesal margins protruding for distal half; pedicel as long as wide, with medial surface flattened, very protruding mesal margins pointed for distal half; antennomere III strongly transverse; antennomers IV-VIII distinctly wider than long with toothed margins; antennomere IX transverse with denticulate margins, the medial one more protruding on distal half, its surface with two tubercles; antennomere X slightly wider than long, with denticulate margins, mesal margin more protruding on distal half, its surface with some tubercles; antennomere XI elongate and distinctly longer than IX-X combined, its surface with many tubercles. Pronotum narrower than head. Metaventrite raised at middle, this area with some very fine punctures and divided by medial sulcus. Ventral surface of protrochanters (Fig. 21) bearing some long bristles, its ventral margin projecting posteriorly as short spine; protibiae slightly enlarged at middle; mesotibiae (Fig. 28) at middle slightly bulging and bearing tuft of short setae, with subapical spur on medial margin; metatibiae enlarged and sinuate on distal half, medial surface flattened for apical third. Abdominal tergites unmodified, first sternite slightly raised and flattened at middle. Aedeagus (Fig. 2) 0.30-0.31 mm long; dorsal plate ovoid with dorsal longitudinal struts divergent. Copulatory pieces with pair of long and wide medial sclerites recurved and sclerotized at base; each sclerite formed by two pieces, the first sclerite wide with apex pointed at its lateral corner, second sclerite thinner and spine-shaped. Parameres wide with one large seta on well-developed outer lobe, apex bent backward and bearing one large subapical seta.

Female: Similar to male except: head not modified, lacking temporal spines; frons with some large punctures only on anterior half; vertexal sulcus impressed; anterior margin of frontal lobe protruding at middle; clypeus without median tooth; large vertexal foveae on each side of eyes, eyes less developed than for male; antennae thinner than for male, with pedicel unmodified; pronotum as wide as head; metaventrite, abdomen, and legs unmodified.

Collecting data: The only available information for this species is that it was collected in October at the coastal massif of Talinay.

Distribution: *Achilia spinifer* is known only from Talinay (Coquimbo Region, Central Chile) (Fig. 55: red squares).

Comments: *Achila spinifer* is the only members of the genus to have the male clypeus bearing a spine. It resembles *A. pullastra* n. sp. in many aspects, notably by the basal striae of first abdominal tergite separated at most by one-third of the tergal width, the frons of the male having two lateral pits with their outer edge toothed, the antennomeres II of the male depressed and toothed, and the endophallus possessing two large copulatory pieces. Characters to distinguish these species in both sexes are provided in the "Comments" section for *A. pullastra.* In the original description Jeannel (1962: 417) mentions that this species was described from 50 specimens collected by Kuschel in Talinay on 23.X.1957. However the type series housed in MNHN consists of only 9 specimens collected on this date (i.e. the holotype and 8 paratypes), and 28 additional specimens also collected by Kuschel in Talinay and labelled as paratypes, but were collected on 16.X.1957, a detail most likely overlooked by Jeannel.

Achilia pullastra n. sp.

Figs 3, 11, 20, 30, 41, 43, 45, 55

Holotype: FMNH (FMHD #2002-027); 1 ♂; CENTRAL CHILI: Región Valparaíso: Quillota prov.: La Campana National Park (sector Granizo), Sendero Los Peumos; 32° 58.3'S 71° 06.4'W; 900 m; 30.XI.2002; A. Solodovnikov; sclerophyll scrub with

Nothofagus obliqua on steepslope, berlese, dry forest, leaf litter.

Paratypes (30 ex.): CENTRAL CHILI: Región Valparaíso: Quillota prov.: FMNH (FMHD #2002-027); 1 ♂; La Campana National Park (sector Granizo), Cajón La Opositora; 32° 58.81'S 71° 07.7'W; 545 m; 29.XI.-29.XII.2002; A. Newton & M. Thayer 1044; sclerophyll forest, flight intercept trap. – FMNH (FMHD #2002-027); 5 ♂ and 16 ♀; La Campana National Park (sector Granizo), Sendero Los Peumos; 32° 58.3'S 71° 06.4'W; 900 m; 30.XI.2002; A. Solodovnikov; sclerophyll scrub with *Nothofagus obliqua* on steep slope, berlese, dry forest, leaf litter. – MHNS; 1 ♂ and 1 ♀; same data. – MHNG (# MHNG-ENTO-45598-45603); 3 ♂ and 3 ♀; same data.

Description: Body 1.65-1.80 mm long, entirely dark brown with reddish, or reddish-brown elytra, abdomen sometimes paler, antennae and legs reddish, and palpi yellowish. Head with eyes moderately protruding, shorter than convex temples. Pronotum wider than long; pronotal disc convex; median antebasal fovea as large as lateral ones, but shallower. Elytra with three basal foveae (two lateral foveae very close, sometimes coalesced as one large fovea); discal stria extending to about elytral midlength. First abdominal tergite with basal striae extending to about one-quarter of paratergal length, and separated at base by about one-third of tergal width. First abdominal sternite with large medial carina extending from its posterior margin to about one-quarter of its length.

Male: Head as in Figs 41, 43, 45, similar to that of *A. spinifer*, but with temporal spines shorter and with deeper basal pits; vertex more conspicuously raised at middle, its surface with large punctures; frons distinctly raised and more densely punctate, anterior margin of frontal lobe straight. Antennae (Fig. 11) with scape longer than wide and mesal margin slightly protruding at middle; pedicel slightly wider than long with flattened medial surface, with slightly protruding mesal margins; antennomeres III-IV transverse; antennomere V longer than wide; antennomere VI as long as wide; antennomere VII slightly longer than wide; antennomere VIII wider than long; antennomere IX slightly wider than long, with denticulates margins, mesal margin protruding, its surface with some small tubercles; antennomere X slightly wider than long, with denticulates margins, its surface with few tubercles; antennomere XI elongate and slightly longer than IX-X combined, its surface with many tubercles. Pronotum narrower than head. Metaventrite raised at middle, and entirely traversed by medial sulcus. Protrochanters (Fig. 20) with ventral margin protruding at middle and bearing some short bristles; protibiae slightly enlarged at middle; mesotibiae (Fig. 30) at middle slightly bulging and bearing a tuft of short setae, with very small subapical spur on medial margin; metatibiae enlarged and sinuate on distal half, their medial surface flattened for apical third. Abdominal tergites unmodified; first sternite slightly raised and flattened at middle. Aedeagus (Fig. 3) 0.29-0.30 mm long; dorsal plate ovoid with dorsal longitudinal struts diverging. Copulatory pieces consisting of pair of long and wide medial sclerites that are recurved and strongly sclerotized at base, sclerites apically pointed, with some small spines on distal third; medial sclerites associated on each side with two short and pointed secondary sclerites. Parameres wide with one large seta on well-developed outer lobe, paramere apex bent backward and bearing one large subapical seta.

Female: Similar to male except: head not modified, without temporal spines; vertex and frons slightly convex with large punctures; vertexal sulcus impressed; clypaeus without median tooth; large vertexal foveae on each side of eyes, the latter less developed than for male; antennae with pedicel unmodified, and antennomeres thinner than for male; pronotum as wide as head; metaventrite, abdomen, and legs unmodified.

Collecting data: Collected in November and December in dry forest from 545 m to 900 m elevation by sifting litter, and with only one specimen taken by a flight intercept trap.

Distribution: *Achilia pullastra* n. sp. is known only from La Campana National Park (Valparaíso Region, Central Chile) (Fig. 55: green diamonds).

Comments: *Achilia pullastra* n. sp. is similar to *A. spinifer,* from which it is easily distinguished by the male features of the head (compare Figs 40 and 41, 42 and 43, 44 and 45), antennae (compare Figs 10 and 11), protrochanters (compare Figs 20 and 21), mesotibiae (compare Figs 28 and 30), and the copulatory pieces of the aedeagus (compare Figs 2 and 3). The females of the two species are very similar, but *A. pullastra* n. sp. has the posterior region of the head punctate, while it is smooth in *A. spinifer*, and the frontal lobe is wider than for *A. spinifer*. See also "Comments" under *A. spinifer*.

Achilia cribratifrons species group

Jeannel (1962: 397, 415) characterized this group as follows: elytra with 2 basal foveae; basal striae of first abdominal tergite separated at most by one-third of tergal width; frons of male with wide median protuberance that is flattened and strongly punctate, without lateral pits; antennomeres of male unmodified. Franz (1996: 120) proposed a new group of species, the *A. angulifrons* group, to hold those species where the parameres had a sickle-shaped apical portion. In addition to *A. angulifrons*, previously attributed by Jeannel (1963: 353, 356) to the *A. cribratifrons* group, he included in this group *A. caneloi* Franz, 1996, *A. parangulifrons* Franz, 1996, *A. pseudangulifrons* Franz, 1996 and *A. simpsoni* Franz, 1996. We consider the establishment of the *A. angulifrons*

group unjustified, as its delimitation overlaps that of the *A. cribratifrons* group, includes species having little else in common. Therefore we treat all the species included by Franz in his *A. angulifrons* group as members of the *A. cribratifrons* group, which would thus consist in: *A. cribratifrons* Jeannel, 1962, *A. angulifrons,* Jeannel 1963, *A. caneloi* Franz, 1996, *A. parangulifrons* Franz, 1996, *A. pseudangulifrons* Franz, 1996, and *A. simpsoni* Franz, 1996.

However our study of the types and other materials revealed that 1) *A. parangulifrons* is a junior synonym of *A. lobifera* Jeannel, 1962, 2) *A. caneloi* is rather a member of the *A. cosmoptera* group, 3) *A. simpsoni* is rather a member of the *A. bicornis* group, and 4) *A. pseudangulifrons* is to be considered as a *species inquirenda*. As a result the *A. cribratifrons* group now only holds *A. cribratifrons* Jeannel, 1962, *A. angulifrons,* Jeannel 1963, and the new species *A. pugila* n. sp. described below.

Achilia cribratifrons Jeannel, 1962

Figs 4, 8, 24, 29, 46, 48, 50, 55

Achilia cribratifrons Jeannel, 1962: 417, figs 174, 175.

Type material (3 ex.): CENTRAL CHILI: Región Bío Bío: Ñuble prov.: MHNS; 1 ♂ (holotype); labels verbatim "Type/ Chillàn, Germain / *Achillia cribratifrons* / *Achillia cribratifrons* (handwritten by Jeannel) / CHILE, M.N.H.N., Typo n. 1797". – MNHN; 1 ♂ and 1 ♀ (paratypes); labels verbatim "Paratype / Chillàn, P. Germain / *Achillia cribratifrons* (handwritten by Jeannel)".

Additional material examined (4 ex.): CENTRAL CHILI: Región Bío Bío: Ñuble prov.: MHNS; 1 ♂ (mislabelled as paratype of *Achilia cribratifrons* n. 1798); Chillàn; P. Germain. – Región Santiago: Santiago prov.: MHNG; 1 ♂; Environs of Santiago, El Arraya; 1963; H. Franz. – MHNW; 1 ♂; same data. – FMNH (FMHD #2002-028); 1 ♂; Road to Farellones, curva 18, Estero Manzanito, NE Santiago; 1890 m; 33°20.90"S 70° 19.63"W; 01.XII.2002; M. Thayer; A. Newton; A. Solodovnikov; D. J. Clarke 1050; dry sclerophyll on slope, introduced trees along stream below, berlese and direct coll., wet debris along stream.

Description: Body 1.65-1.75 mm long, head, pronotum and elytra reddish-brown, abdomen dark brown, antennae and legs reddish, and palpi yellowish. Head wider than long with vertexal sulcus well-impressed; eyes slightly protruding, shorter than very weakly convex temples. Pronotum wider than head and wider than long; pronotal disc convex; median antebasal fovea smaller than lateral ones. Elytra with two basal foveae, the lateral one very large; discal stria extending to about elytral midlength. First abdominal tergite with basal striae extending to about one-quarter of paratergal length, and separated at base by about one-third of tergal width. First abdominal sternite with medial carina extending from its posterior margin to about one-quarter of its length.

Male: Head as in Figs 46, 48, 50, with vertex and frons raised and flattened with carinate lateral margins, and dorsal surface densely and strongly punctate; one small tooth curved medially above each eye; anterior margin of frontal lobe straight and carinate; clypeal area deeply hollowed, its anterior margin raised and pubescent. Antennae (Fig. 8) with scape distinctly longer than wide; pedicel longer than wide; antennomeres III-IV distinctly wider than long; antennomere V as long as wide; antennomere VI transverse; antennomere VII slightly wider than long; antennomere VIII transverse, its mesal margin slightly protruding; antennomere IX transverse with very protruding mesal margin pointed at middle; antennomere X wider than long with protruding mesal margin; antennomere XI elongate and slightly shorter than VII-X combined, its surface with many tubercles. Metaventrite with wide median ovoid depression occupying its distal half to posterior margin, depression densely punctate. Ventral surface of protrochanters bearing some long setae; protibiae (Fig. 24) distinctly enlarged for distal half with indented distal apex; mesotibiae (Fig. 29) at middle slightly bulging and bearing tuft of short setae, with small subapical spur on medial margin; distal half of metatibiae slightly sinuate. Abdominal tergites unmodified, surface of first ventrite slightly raised and flattened at middle, this area finely punctate. Aedeagus (Fig. 4) 0.275-0.280 mm long; dorsal plate ovoid with dorsal longitudinal struts divergent. Copulatory pieces consisting of pair of long medial recurved sclerites, sclerites strongly sclerotized at base and apically pointed, associated on each side with one long pointed sclerite. Parameres wide with one long seta on well-developed outer lobe, and apex bent backward and bearing one very large subapical seta.

Female: Similar to male except: head not modified; vertex and frons slightly convex with large punctures; small vertexal foveae on each side of eyes, the latter less developed than for male; antennae thinner than for male; metaventrite, abdomen and legs unmodified.

Collecting data: The only detailed collecting data available refer to a male found in December at an altitude of 1890 meters in a dry sclerophyll forest.

Distribution: *Achilia cribratifrons* is known only from Ñuble and Santiago provinces in Central Chile (Fig. 55: blue triangles).

Comments: This species is easily distinguished from its congeners by the unique shape of the male head (Figs 46, 48, 50), and the morphology of the aedeagus (Fig. 4).

Achilia pugila n. sp.

Figs 5, 13, 25, 31, 47, 49, 51, 55

Holotype: MHNG (# MHNG-ENTO-45604); 1 ♂; CENTRAL CHILI: Región Santiago: Santiago prov.: Cuesta El Melon; 03.XI.1965; Nr. P-B.80-3; Loksa; Hungarian Soil-Zool. Exp.

Description: Body 1.60 mm long, entirely dark brown with reddish elytra darker at base; antennae and legs reddish, palpi yellowish. Head wider than long, with vertexal sulcus shallowly impressed; eyes very protruding, longer than very weakly convex temples. Pronotum about as wide as head, wider than long; pronotal disc slightly convex; median antebasal fovea smaller than lateral ones. Elytra with two basal foveae, lateral one very large; discal stria extending to about elytral midlength. First abdominal tergite with basal striae extending to about one-fourth of paratergal length, and separated at base by about one-fourth of tergal width. First abdominal sternite with median carina extending from its posterior margin to about one-fourth of its length.

Male: Head as in Figs 47, 49, 51, similar to that of *A. cribratifrons*, but the raised area slightly punctate with smaller and sparse punctures, larger tooth above each eyes, clypeal area barely hollowed, its anterior margin scarcely raised. Antennae (Fig. 13) with scape distinctly longer than wide; pedicel about as long than wide, antennomeres III-VII distinctly transverse, antennomere VIII also transverse, its medial margin widened and pointed at basal corner, antennomere IX strongly transverse with strongly protruding mesal margin that is pointed at the middle and bears 2 long setae, two other long setae are inserted on its dorsal surface; antennomere X very large, longer than wide, with protruding mesal margin bearing some short setae at basal corner and two long setae at distal corner; its medial surface hollowed in basal third and bearing some long setae, antennomere XI elongate and about as long as IX-X combined. Metaventrite with wide median ovoid depression occupying its distal half up to its posterior margin. Surface of depression densely punctate. Protibiae (Fig. 25) distinctly enlarged for distal half and with two small subapical spurs on medial margin; mesotibiae (Fig. 31) at basal third distinctly bulging, bearing tuft of short setae and with subapical spur on medial margin; distal half of metatibiae slightly sinuate. Abdominal tergites unmodified, surface of first ventrite slightly raised and flattened at middle, this area finely punctate. Aedeagus (Fig. 5, dorsal longitudinal struts partially shown) 0.275 mm long; with ovoid dorsal plate, dorsal longitudinal struts divergent. Copulatory pieces consisting of pair of long medial recurved sclerites, strongly sclerotized at base and apically pointed and curved inwards, associated on each side with one shorter bifid sclerite. Wide parameres with one thin seta on well-developed outer lobe, and apex bent backward and bearing one large subapical seta.

Female: Unknown.

Collecting data: The only specimen was collected in November.

Distribution: *Achilia pugila* n. sp. is known only from Cuesta El Melon (Santiago province, Central Chili) (Fig. 55: fuchsia stars).

Comments: *Achilia pugila* n. sp. is similar to *Achilia cribratifrons* from which it is easily distinguished by features of the male antennae (compare Figs 8 and 13), head (compare Figs 47, 49 and 51, with Figs 46, 48 and 50), protibiae (compare Figs 24 and 25), mesotibiae (compare Figs 29 and 31), and the copulatory pieces of the aedeagus (compare Figs 4 and 5).

Achilia angulifrons Jeannel, 1963

Figs 6, 9, 22, 26, 32, 52-55

Achilia angulifrons Jeannel, 1963: 353, 365 figs. 12 (head and antennae), 13 (aedeagus).

Type material (1 ex.): CENTRAL CHILI: Región Valparaíso: Valparaíso prov.: MNHN; 1 ♂ (holotype); labels verbatim "Type / Cerro El Roble, 18.VIII.1961, F. Castri / *Achillia anguliceps* (handwritten by Jeannel)".

Description: Body 1.65 mm long, entirely reddish, with dark brown abdomen; antennae and legs reddish, palpi yellowish. Head wider than long with vertexal sulcus impressed; eyes very protruding, longer than very slightly convex temples. Small vertexal foveae beside eyes. Pronotum narrower than head, slightly wider than long, with disc slightly convex; median antebasal fovea smaller than lateral ones. Elytra with two basal foveae, the lateral one very large; discal stria extending to about elytral midlength. First abdominal tergite with basal striae extending to about one-fourth of paratergal length, separated at base by about one-third of tergal width. First abdominal sternite with median carina extending from posterior margin to about one-fourth of its length.

Male: Head as in Figs 52-54, triangular, densely punctate, with frontal lobe narrow and pointed, and sides strongly convergent; frons flattened and slightly raised; vertex with carinate sides; supra-ocular margins forming small tooth. Antennae (Fig. 9) with scape and pedicel distinctly longer than wide; antennomeres III-IV distinctly wider than long; antennomere V as long as wide; antennomeres VI-VII slightly wider than long; antennomere VIII distinctly wider than long; antennomeres IX-X wider than long; antennomere XI elongate and longer than VII-X combined, its surface with many tubercles. Metaventrite with wide medial ovoid depression occupying its distal half up to its posterior margin, surface of depression densely punctate. Ventral margin of protrochanters (Fig. 22) and mesotrochanters with some long setae; protibiae (Fig. 26) enlarged and slightly flattened in distal half with indented distal apex; mesotibiae (Fig. 32) at middle slightly bulging, bearing tuft of short setae and small

subapical spur on medial margin; distal half of metatibiae slightly sinuate. Abdominal tergites unmodified, surface of first sternite slightly raised and flattened at middle, this area finely punctate. Aedeagus (Fig. 6) 0.385 mm long; with ovoid dorsal plate, dorsal longitudinal struts divergent. Copulatory pieces consisting of pair of long medial recurved sclerites strongly sclerotized at base, apically pointed and slightly curved inwards, associated on each side with shorter large sclerite narrowed and apically pointed. Parameres very wide, bearing very long well-developed seta on outer lobe, and one large and thin subapical setae.
Female: Unknown.

Collecting data: The only specimen of this species was collected in August, 210 m above sea level, 20 cm deep in leaf litter at the foot of a *Nothofagus nitida* (Jeannel, 1963: 351).

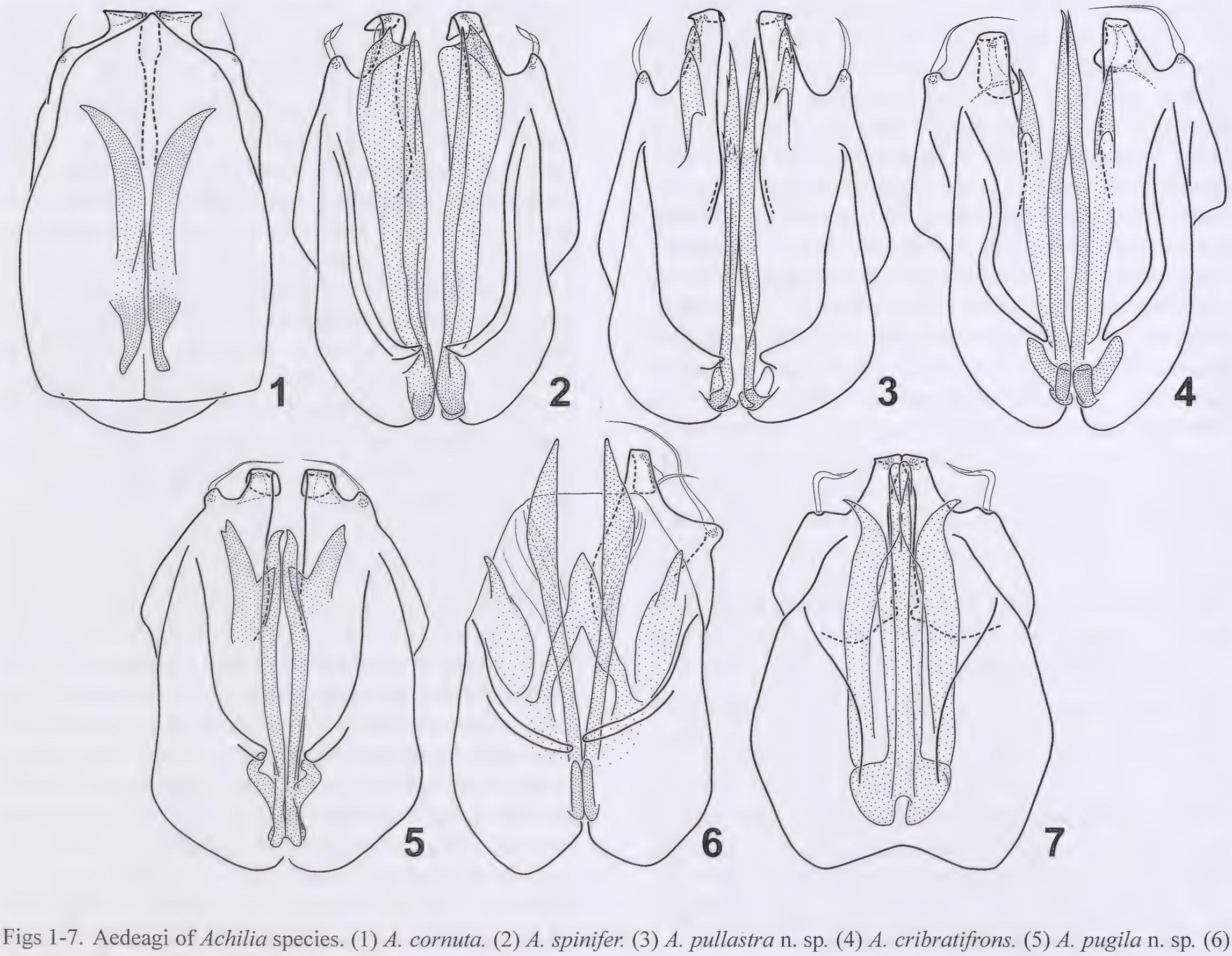
Distribution: *Achilia angulifrons* is known only from Cerro el Roble (Valparaíso province, Central Chili) (Fig. 55: square edged in green).

Comments: The label "*Achillia anguliceps*" hand-written by Jeannel and attached to the holotype is a labeling mistake of Jeannel, as the locality data correspond perfectly to those mentioned in the description, and no "*Achillia anguliceps*" was ever described. The male of *A. angulifrons* is easily separated from its congeners by the diagnostic morphology of the head (Figs 52-54) and of the aedeagus (Fig. 6). See the "Comments" section below for *A. pseudangulifrons*.

Achilia caneloi Franz, 1996

Achilia caneloi Franz, 1996: 122.

Comments: We have examined the holotype and only known specimen of *A. caneloi*, which is housed in NHMW. It appears to be a member of the *cosmoptera* group, and therefore will be dealt in a subsequent part of our revision of *Achilia*.



Figs 1-7. Aedeagi of *Achilia* species. (1) *A. cornuta.* (2) *A. spinifer.* (3) *A. pullastra* n. sp. (4) *A. cribratifrons.* (5) *A. pugila* n. sp. (6) *A. angulifrons.* (7) *A. monstrata.*

Achilia parangulifrons Franz, 1996

Achilia parangulifrons Franz, 1996: 121, fig. 72 (aedeagus).

Type material (1 ex.): CENTRAL CHILI: Región Bío Bío: Concepción prov.: MHNW; 1 ♂ (holotype); labels verbatim "Holotype / Chili, Periquillo, 26.VIII.1991, H. Franz / *Achillia parangulifrons* (handwritten by Franz)".

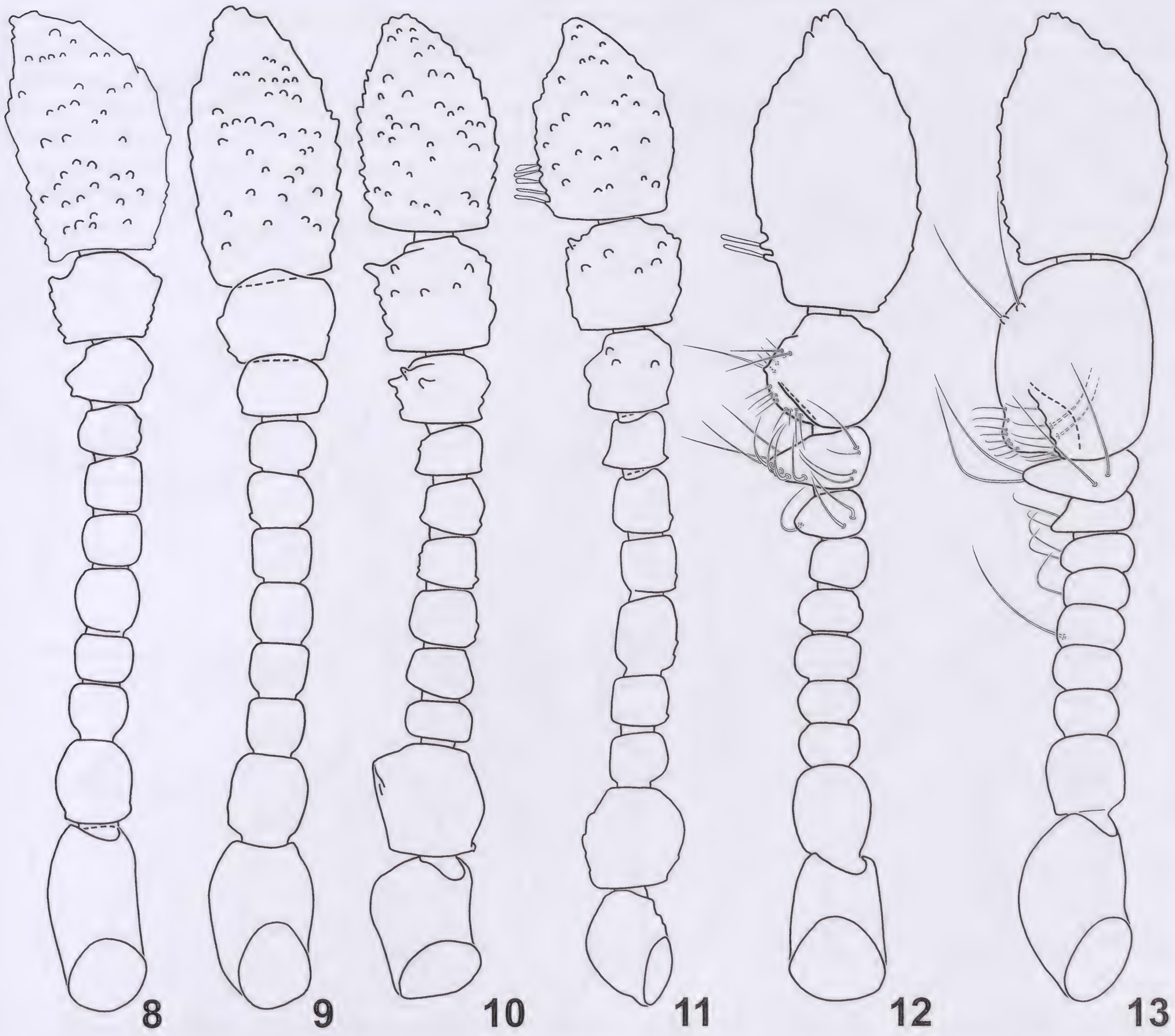
Comments: We have examined the holotype, which appeared to be a male of *A. lobifera* Jeannel, 1962, a species we recently revised (Sabella *et al.*, 2017). Therefore, we here place *A. parangulifrons* Franz, 1996 as a junior synonym of *A. lobifera* Jeannel, 1962 (**syn. nov.**).

Franz (1996: 121) described also *A. parangulifrons* var. *mehuini*, based on a male labeled "Cordillera de la Costa bei Mehuin, Cerro Mutro, ca. 600 m, Bosque Valdiviano, Waldstreugesiebe, 31.X.1968, leg. Franz". According to Franz it differed from *A. parangulifrons* only by the configuration of the lateral sclerites of the internal sac of the aedeagus, which were not illustrated. We could not locate this specimen in the Franz collection. Anyways it referred to a taxon of infra-subspecific rank described after 1960, and thus unavailable with respect to the ICZN (1999).

Achilia pseudangulifrons Franz, 1996

Achilia pseudangulifrons Franz, 1996: 120.

Comments: Franz (1996) described *A. pseudangulifrons* based on a single male collected on Chiloé Island. We could not find this type, which should have been in his collection now housed in NHMW. According to the original description, the species is very similar to *A. angulifrons* from Valparaiso,



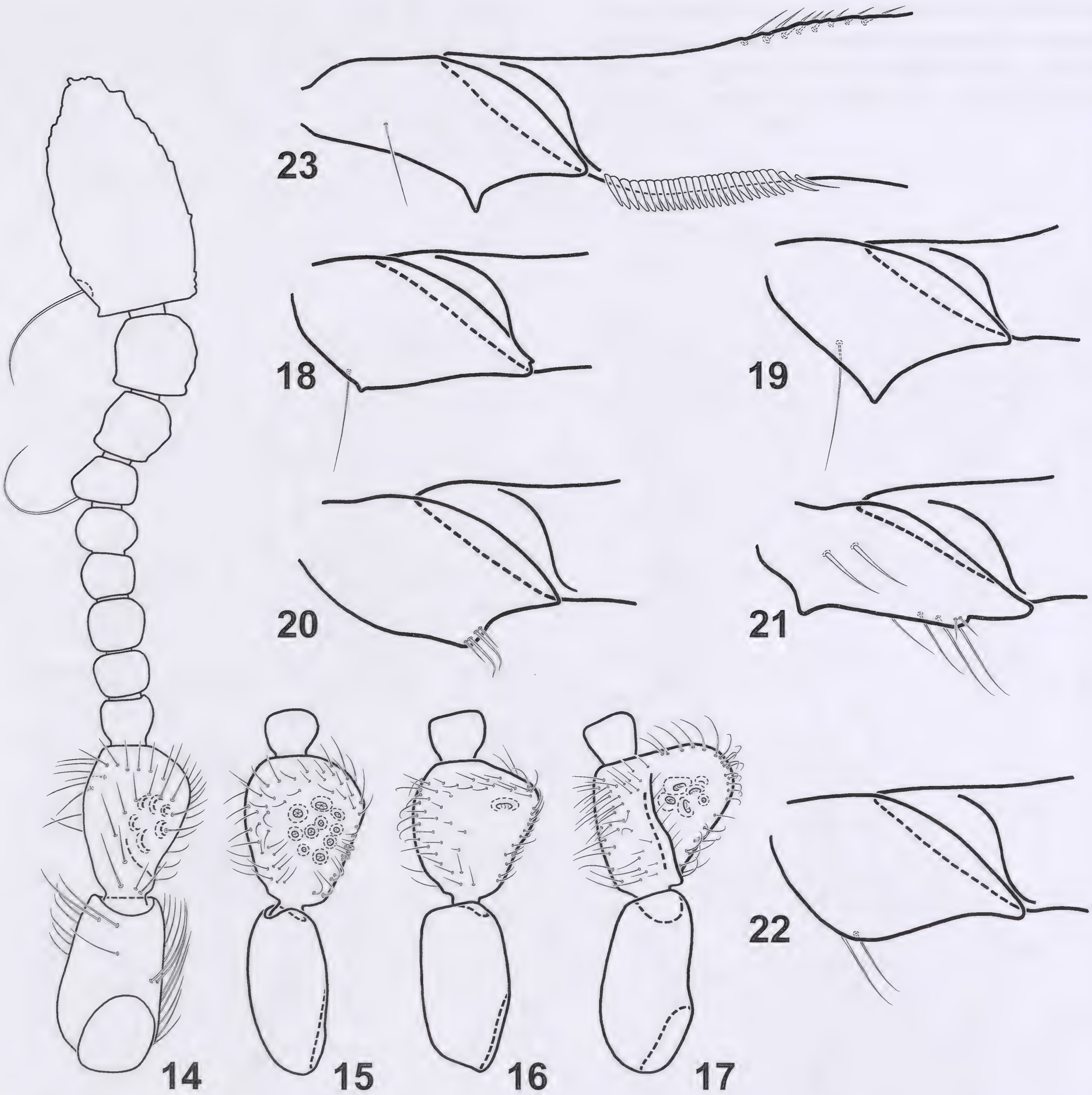
Figs 8-13. Male antennae of *Achilia* species. (8) *A. cribratifrons.* (9) *A. angulifrons.* (10) *A. spinifer*. (11) *A. pullastra* n. sp. (12) *A. cornuta*. (13) *A. pugila* n. sp.

notably with respect to the shape of the male head being triangular in dorsal view. However, the genitalia of *A. pseudangulifrons*, which was unfortunately not illustrated, was characterized as possessing parameres that lacked an outer lobe, and their apical part was only half as long as wide. These features are in sharp contrast with all the other species of the *A. cribratifrons* group, which all possess parameres with a well-developed outer lobe that have their apical part long and slender. At this time we have no idea as to which group of species *A. pseudangulifrons* could belong, and even the possibility that the species was described based on a chimeric specimen remains open. Therefore we have decided to consider this taxon as a *species inquirenda.*

Achilia simpsoni Franz 1996

Achilia simpsoni Franz, 1996: 121 fig. 73 (aedeagus).

Comments: We have examined the types (i.e. the holotype and four paratypes) of this species, which are housed in NHMW. It appeared that they belong rather to the *A. bicornis* group of species, which will be treated afterwards.



Figs 14-23. Male antenna (14), variability of the base of antennae (15-17), protrochanters (18-22), mesotrochanter and base of mesofemur (23) of *Achilia*. (14-16) *A. monstrata*, specimens from Laguna Triangulo to Alerce Andino National Park. (17, 19, 23) *A. monstrata*, specimen from Alerce Costero National Park. (18) *A. cornuta.* (20) *A. pullastra* n. sp. (21) *A. spinifer*. (22) *A. angulifrons*.

Achilia monstrata species group

Jeannel (1962: 397-398, 418) characterized this group as follows: elytra with 3 basal foveae; basal striae of first abdominal tergite separated at most by one-third of tergal width; frons of male with high median protuberance concave on anterior margin; antennal pedicel of male medially bulging; internal sac of aedeagus with two large subequal copulatory pieces.

Achilia monstrata (Reitter, 1885)

Figs 7, 14-17, 19, 23, 33, 36-39, 55

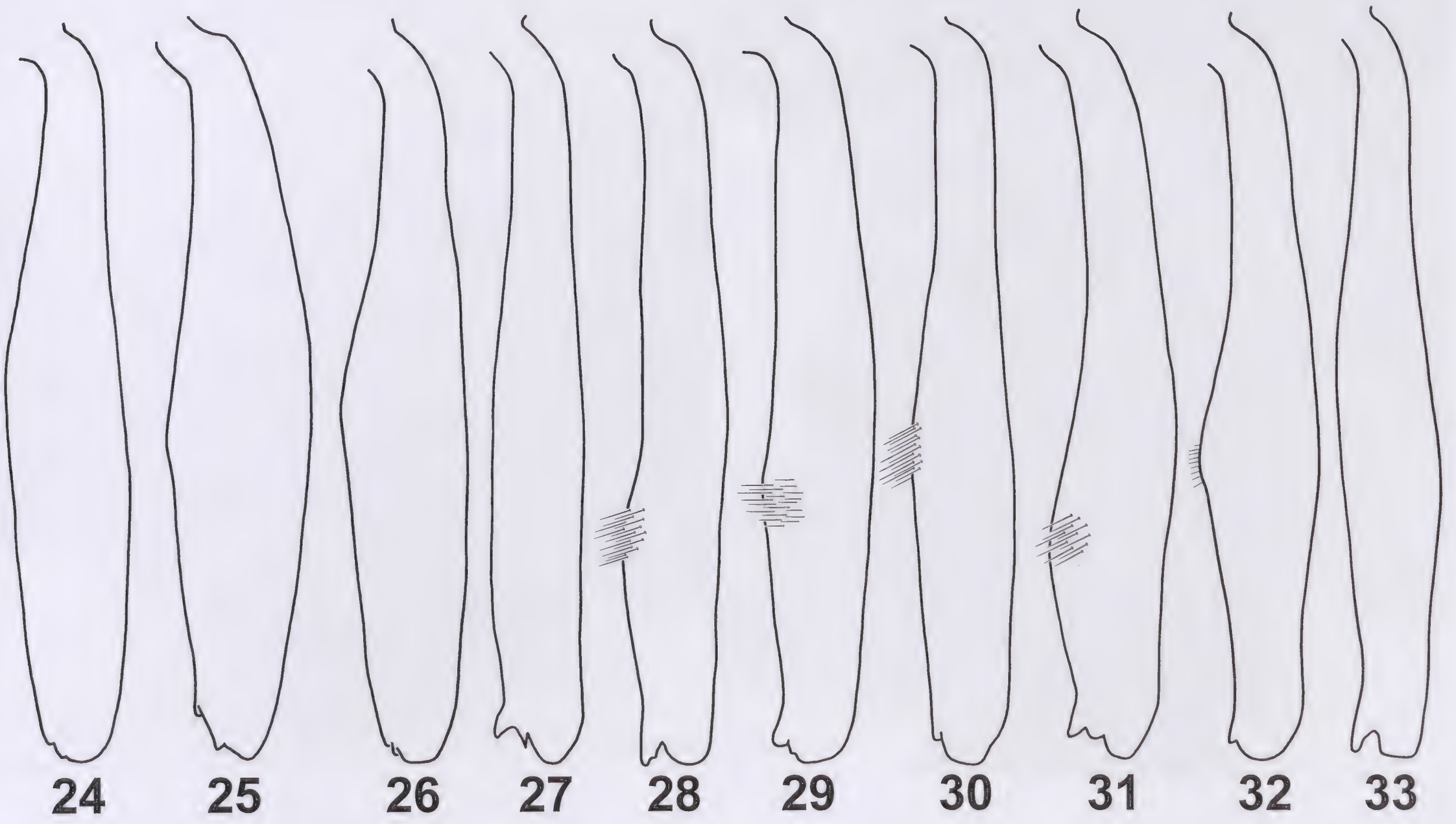
Bryaxis monstrata Reitter, 1885: 327, pl. 2 fig. 6 (head and antennae).

Achilia monstrata monstrata Jeannel, 1962: 418, figs 176 (habitus), 177 (head), 178 (aedeagus).

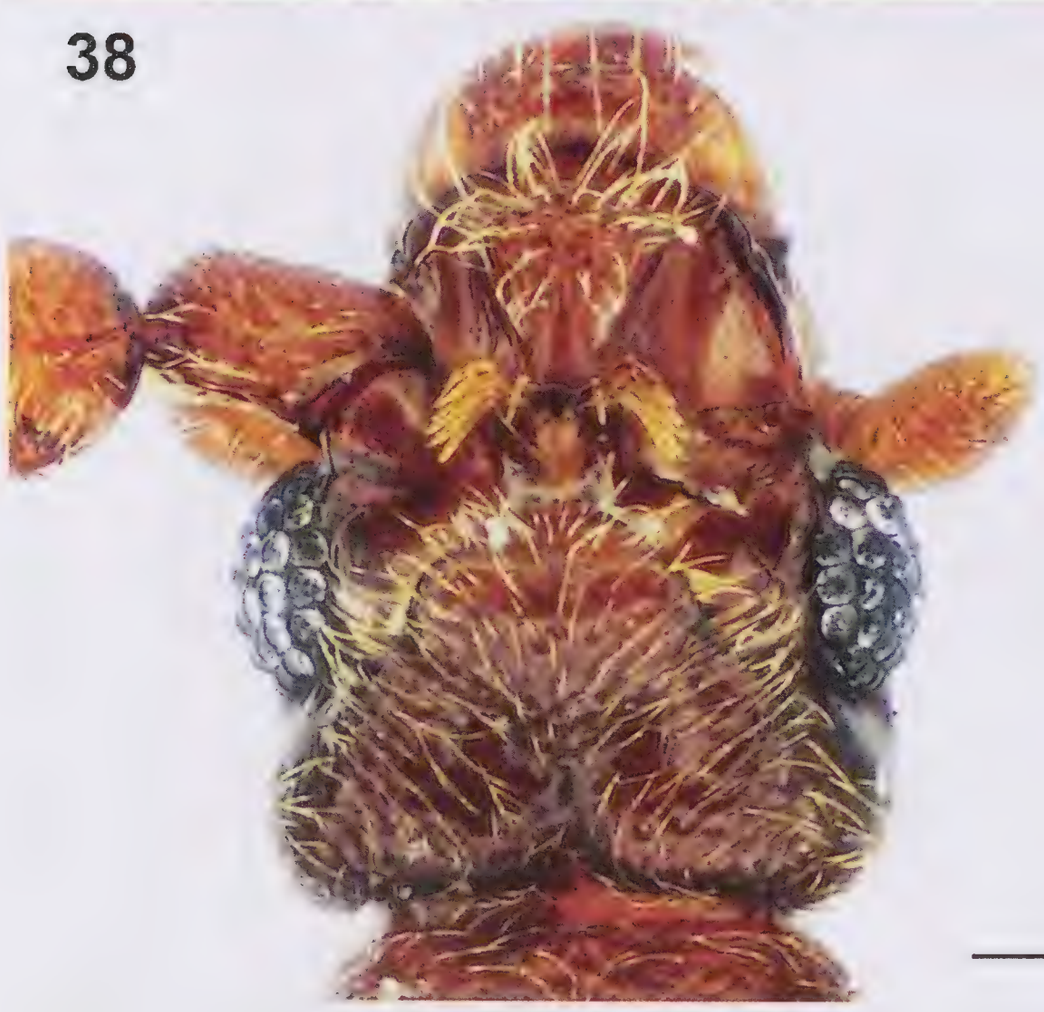
Achilia monstrata chilota Jeannel, 1962: 418, (**syn. nov.**).

Type material (4 ex.): MNHN; 1 ♂ (holotype of *A. monstrata*); Chile; labels verbatim "Type / Chili / *Achillia monstrata* (handwritten by Jeannel)". – SOUTHERN CHILI: Región Los Lagos: Chiloé prov.: MHNS; 1 ♂ (holotype of *Achilia monstrata chilota*); labels verbatim "Type / CHILE, Chiloé, Sn. Pedro, 08.XI.1958, Kuschel / *Achilia monstrata chilota* Jeannel / *A. monstrata* v. *chilota* (handwritten by Jeannel) / CHILE, M.N.H.N., Typo, n. 1799". – MNHN; 1 ♂ and 1 ♀ (paratypes of *Achilia monstrata chilota*); labels verbatim "Type / CHILE / San Pedro, 08.XI.1958, Kuschel / *A. monstrata* v. *chilota* (handwritten by Jeannel)".

Additional material examined (18 ex.): SOUTHERN CHILI: Región Los Lagos: Llanquihue prov.: MHNG; 1 ♂ and 1 ♀; Alerce Andino National Park, above Laguna Chaiquenes, station 37; 41° 40'S 72° 35'W; 350-650 m; 04.I.1993; D. Burckhardt; mixed *Fitzroya cupressoides* forest with thick moss cover inside, sifting of moss on floor and tree trunks and vegetational debris, hardwoods, berlese, litter. – MHNG; 3 ♂; Alerce Andino National Park, Laguna Triàngulo, station 38b; 41° 40'S 72° 35'W; 550 m; 05-06.I.1993; D. Burckhardt; sclerophill rain forest, sifting of moss on tree trunks and of vegetational debris. – FMNH (FMHD #97-28); 1 ♂; Alerce Andino National Park, near Sargazo entrance, 11.4 km from Correntoso; 41° 30'S 72° 37'W; 350 m; 19.I.1997; A. Newton & M. Thayer 998; Valdivian rainforest, berlese, leaf & log litter. – FMNH (FMHD #97-26); 1 ♂ and 2 ♀; Lago Chapo, 1.2 km N of NW end; 41° 25'S 72° 35'W; 265 m; 19.I.1997; A. Newton & M. Thayer 996; small secondary *Nothofagus dombeyi* w/Valdivian rainforest understory, berlese, leaf & log litter. – Chiloé prov.: MHNS; 1 ♀ (mislabeled as paratype of *Achilia monstrata chilota* n. 1800) San Pedro; 08.XI.1958; G. Kuschel. – MHNG; 1 ♂; Chiloé, H. Franz. – MHNG; 1 ♀; Piruquina; 23.I.1970; T. Cekalovic. – PHPC; 1 ♂; Chiloé Island, Cucao; WDS-T-209; 02.III.2008; 42° 35'S 74° 05'W; W. D. Shepard, sifting litter. – Región Los Ríos: Valdivia prov.: MHNG; 3 ♂; Parque Nacional Alerce Costero, Chaihuin; 350 m; 16.II.2018; G. Sabella & D. Mifsud; sifting litter. – MHNG; 2 ♀; same locality; 0-100 m; 16.II.2018; S. Kurbatov; forest litter.



Figs 24-33. Male protibiae (24-26) and mesotibiae (27-33) of *Achilia*. (24, 29) *A. cribratifrons*. (25, 31) *A. pugila* n. sp. (26, 32) *A. angulifrons*. (27) *A. cornuta*. (28) *A. spinifer*. (30) *A. pullastra*. (33) *A. monstrata*.



Figs 34-39. (34-35) *Achilia cornuta*. (36-39) *A. monstrata* from (36-37) Llanquihue and (38-39) Valdivia. Male head in (34, 36, 38) dorsal and (35, 37, 39) lateral views. Scale bars (200 μm) vertical for (34-35) and horizontal for (36-39).

Figs 40-45. (40, 42, 44) *Achilia spinifer*. (41, 43, 45) *A. pullastra* n. sp. Male head in (40-41) dorsal, (42-43) lateral and (44-45) frontal views. Scale bars (200 µm) left for (40, 42, 44) and right for (41, 43, 45).

Figs 46-51. (46, 48, 50) *Achilia cribratifrons.* (47, 49, 51) *A. pugila* n. sp. Male head in (46-47) dorsal, (48-49) lateral views, and (50-51) male eye in frontal view. Scale bars (200 µm) left for (46, 48) and right for (47, 49).

Figs. 52-54. *Achilia angulifrons*. Male head in (52) dorsal and (53) lateral views, and (54) male eye in frontal view. Scale bar (200 µm) for (52-53).

Fig. 55. Distribution map. (● red circles) *Achilia cornuta*. (■ red squares) *A. spinifer*. (◆ green diamonds) *A. pullastra* n. sp. (▲ blue triangles) *A. cribratifrons*. (★ fuchsia stars) *A. pugila* n. sp. (□ squares edged in green) *A. angulifrons*. (▼ red inverted triangles) *A. monstrata*.

Description: Body 1.6-1.75 mm long, colouration variable from entirely reddish to reddish with darkened abdomen, or entirely brown with reddish elytra; antennae and legs reddish, palpi yellowish. Head wider than long, lacking vertexal sulcus; eyes protruding, longer than very slightly convex temples. Pronotum wider than head and wider than long; pronotal disc convex. Elytra with four basal foveae (two lateral foveae very close); discal stria extending to about elytral midlength. First abdominal tergite with diverging basal striae extending to about one-fourth of paratergal length, separated at base by about one-third of tergal width. First abdominal ventrite with median carina extending from its posterior margin to about one-fourth of its length.

Male: Head as in Figs 36-39. Vertex and posterior half of frons raised in rectangular plate with sides more or less narrower anteriorly, anterior margin of this plaque excavated, in front of it large median tubercle bifid, bearing dense tuft of bristles at each apex; anterior margin of frontal lobe protruding. Antennae (Figs 14-17) with scape distinctly longer than wide; ventral surface of pedicel with some large pores, more or less excavated and variable from longer than wide with distal half of mesal margin protruding to wider than long with distal half of mesal margin very protruding; antennomeres III-IV about as wide as long, antennomere V as long as wide, larger than previous ones; antennomeres VI-VII slightly wider than long; antennomere VIII distinctly wider than long, its mesal margin enlarged and at basal half pointed and with long bristle; antennomere IX slightly wider than long; antennomere X about as long as wide; antennomere XI elongate, longer than VII-X combined. Metaventrite raised at middle, this area with some fine punctures and divided by wide medial sulcus, with ventral margin of protrochanters (Fig. 19) and mesotrochanters (Fig. 23) projecting posteriorly as spine; basal third of ventral margin of mesofemurs densely covered with large bristles (Fig. 23); mesotibiae (Fig. 33) with apical spur on medial margin; distal half of metatibiae slightly sinuate. Abdominal tergites unmodified; first ventrite raised from middle up to and including its posterior margin. Aedeagus (Fig. 7) 0330-0.340 mm long; with ovoid dorsal plate, dorsal longitudinal struts reduced and divergent. Copulatory pieces consisting of median sclerite associated with pair of recurved longer and thinner medial sclerites, strongly sclerotized at base, apically pointed and curved inwards, associated on each side with one long sclerite that is apically pointed and recurved outwards. Parameres wide with one very large seta on well-developed outer lobe, apex bent backward and bearing one subapical seta.

Female: Similar to male except: head not modified, its dorsal surface slightly concave anteriorly, sparsely punctate; pair of large vertexal foveae between eyes, the latter less developed than for male; antennae shorter and thinner than for male; metaventrite, abdomen and legs unmodified.

Collecting data: Collected from November to February in different types of forests at elevations ranging from 0 m to 650 m. All specimens came from sifted samples of leaf and log litter, sometimes mixed with moss.

Distribution: *Achilia monstrata* is known from Southern Chili ranging from Llanquihue Province to Valdivia Province (Fig. 55: red inverted triangles). Jeannel (1964: 10) also reported it for Nahuelbuta National Park (37° 45' S), 650 m, F. Di Castri, IV.1962, 1 ♀. We did not found this specimen in the MNHN collection, and considering that this report was based on a female from a region quite distant from the area currently delimited for this species, this placement requires confirmation. We did not take this record into consideration for the distribution map.

Comments: Jeannel (1962: 419) recognized two subspecies of *A. monstrata* – i.e. *A. m. monstrata* from Valdivia, and *A. m. chilota* from Chiloé Island – distinguished by characters of the male head. According to Jeannel the nominal subspecies has the frontal plate rectangular and longer than wide, with the sides not restricted anteriorly, and the anterior margin of the frontal lobe is "engraved" at the middle, while for *A. m. chilota* the frontal plate is distinctly shorter (wider than long), with the sides restricted anteriorly, and the anterior margin of frontal lobe is not "engraved". The aedeagal conformation of all males examined, including the two holotypes, is widely comparable to that shown in Fig. 7, without significant differences. Moreover the males of this taxon show significant variability of the shape of the frontal plate of the head (cf. Figs 36 and 38, and 37 and 39), and of the pedicel of the antennae (cf. Figs 14-17), even in specimens from the same locality. Therefore we consider that *Achilia monstrata chilota* Jeannel, 1962 is a junior synonym of *Achilia monstrata* (Reitter, 1885) (**syn. nov.**).

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